CONVAIR
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CHAPTER I

THE FOUNDING

Like a great river, Convair derives from many sources. The main stream begins with Consolidated in 1923. Some of the tributaries reach farther back -- like the Thomas line of aircraft to 1910. But Thomas, for example, did not merge with Consolidated until 1929, so we follow the main stream and take up the tributaries as they enter.

The first World War built the American aircraft industry into a giant over night. Military plane deliveries in 1916 totaled just 64 machines. By the autumn of 1918, production of the De Havilland 4 alone had reached a rate of 13,500 planes a year.

Peace came November 11, 1918. Within three days contracts for $100,000,000 in aircraft were canceled. The auto magnates, whose capital and knowhow had built up plane production, went back to making autos. The dedicated airmen and a handful of hopeful businessmen carried on. By 1923, Col. Dwight F. Davis, assistant secretary of war, was warning that military and civilian aviation alike faced starvation.

The year 1923 brought the launching of a new company at East Greenwich, R.I. The firm was called Consolidated Aircraft. The principal figures were two officers who had left the dwindling Army Air Service -- Maj. R. H. Fleet and Col. V. E. Clark. The company was put together of the remnants of two firms, Gallaudet and Dayton-Wright, that had failed to weather the post-war years of famine.

Reuben Hollis Fleet -- The founding father, then 36 years old, was a self-made businessman and ex-legislator who had served five years in the Air Service. He had $15,000 and knew where he could raise $10,000 more. He also had total faith in the future of aviation.

Fleet was born March 6, 1887, in Montesano, Wash. As a youngster he sometimes worked in the woods with his father, a timber buyer who had reached the Pacific Northwest from Kansas City by foot, horseback and stage coach. Rube finished grade school and entered

Culver Military Academy, graduating in 1906 with an appointment to West Point. The Army ruled he would have to wait two years (until he was 21) to enter. By that time, Fleet was launched on a business career of his own as timber appraiser and real estate dealer.

Fleet struck his first blow for aviation in 1915, as adjutant of the Washingtion National Guard and youngest member of the State Legislature. With an aviator friend at the controls of a homemade plane, he circled the dome of the state capitol for 35 minutes -- then introduced a bill appropriating $250,000 for aviation training in the National Guard. (This tipped the $225,000 appropriation Congress had voted for the entire country.) As Fleet expected, passage of the bill in the lower house attracted national attention. He let the measure die after the Signal Corps Aviation Section agreed to press Congress for funds to train one guardsman from eact state annually.

Fleet won such an appointment from his state in 1917, and reported to the Army's Rockwell Field aviation school at San Diego on March 29. Eight days later the country was at war with Germany. After winning his wings, Fleet spent most of the war period in Washington as one of the officers in charge of the aviation training program.

In the spring of 1918 he received new duty when the Post Office Department inaugurated the first regular air mail service between Washington and New York City. The Signal Corps supplied aircraft and pilots, and Fleet was named officer in charge by Col. H. H. "Hap" Arnold, assistant Air Corps chief.

It was an auspicious occasion May 15, when the first eastbound flight took off from the Polo Grounds. The notables on hand included President and Mrs. Woodrow Wilson and Franklin D. Roosevelt, assistant secretary of the Navy. Fleet dispatched Lt. George Boyle on the Philadelphia leg of the trip with 350 pounds of 24-cent mail, but the hapless flier lost his way and his JN-4 "Jenny" nosed over 20 minutes later in a Maryland cow pasture. His mail was retrieved and forwarded by train. Fleet's westbound mail fared better. Lt. J. C. Edgerton completed the Philadelphia-Washington leg in late afternoon and a squadron of Boy Scouts deployed through the capital, delivering 500 letters and parcels.

Civilian fliers took over carrying the mail July 15, and in September, Fleet sailed for England on the troopship Olympic. Arnold, who was aboard as troop commander, was coming down the pneumonia. He charged Fleet with correcting the unmilitary appearance of the aviation officers and chaplains. Recalling the voyage long afterward, Arnold wrote:

"The next thing I remember clearly was being put into an ambulance on the Southampton dock.....Not a sound was heard until a faint murmur reached us from ahead. As we drew closer the sound became more distinct. It was Maj. Reuben Fleet, marching his chaplains and Air Corps officers from Southampton to Winchester, at attention, in the rain, in the dark, at eleven o'clock at night. 'One, two, three, four. Damn you, chaplains, keep in step. One, two, three, four. Damn you, chaplains, keep in step' . . . He was making soldiers of them."*

After graduating from Britain's school for flying instructors at Gosport, Fleet returned and was stationed in Dayton as business manager of McCook Field and contract officer for the Air Service. Through the mid-Twenties, McCook was the home of the Engineering Division, which kept post-war aviation progress alive with a program of original design, prototype construction and rigorous testing. Fleet remained at this crossroads of military aviation from January, 1919, until fall of 1922 -- negotiating contracts with manufacturers, purchasing material from suppliers, and rubbing elbows with Air Service lawyers, engineers and fliers.

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* Arnold, Global Mission (1949), Pp. 83-84.

When he decided to quit the service and make his fortune in private industry, Fleet turned down executive jobs with two well-established companies (Boeing and Curtiss) to become vice president and general manager of the Gallaudet Aircraft Corp. at East Greenwich. "I remember clearly why I chose Gallaudet," he had said.* "Its financial backers embraced the wealth of the country -- men like Harry Payne Whitney, who was worth 200 million dollars."

Gallaudet Aircraft Corp. -- Fleet resigned from the Air Service November 30 and took over management of a company that had lost nearly $3,000,000 since the war. Now it was keeping alive by spreading itself in two directions: Part of the factory was devoted to aircraft manufacture, the rest to the fabrication of featherboards (the slender wood slats on which bolts of cloth are wound).

The founder of the company had resigned earlier in the year. He was Edson F. Gallaudet, a pioneer aeronautical engineer. He had become fascinated as a child with man's dream of flight. After graduating from Johns Hopkins with a doctor's degree in engineering in 1896, he taught physics at Yale, but spent so much of his spare time on aeronautical experiments that older faculty members labeled him eccentric.

Gallaudet may have discovered the wing-warping principle earlier than the Wrights, who hit upon it in July, 1899. The pioneer gliders -- Lilienthal, Chanute and others -- corrected the tipping of a wing by shifting their weight. The Wrights determined that the same effect could be achieved mechanically by altering the wing's camber. (Glenn H. Curtiss subsequently fashioned an aileron for this purpose; years of bitter patent litigation followed.) A drawing published in 1920 shows a Gallaudet wing-warping model dated July, 1898. If this was correct, he had perceived the idea first but failed to perfect it.

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* Interview at San Diego, February, 1956.

In 1908, Gallaudet opened a consulting engineer's office at Norwich, Conn. In 1911, he learned to fly at the Wright Brothers' school and visited France, where he obtained a French pilot's license and studied operations with his brother, Dennison. In 1912, they exhibited the Gallaudet A-1 Bullet at New York City's first Aero Show held in May at Grand Central Palace. It was a stubby, low-wing monoplane having the pusher propeller mounted aft of the tail section. The Bullet cracked up two months later, injuring Gallaudet. He estimated its speed at the time at 130 m.p.h. -- a velocity that few of the swiftest fighters of World War I would attain.

Gallaudet's next design appears to have been a monoplane flying boat, the Model B; this was the work in hand when Felix Rossoll, an 18-year-old Norwich schoolboy, got a job with the Gallaudet Co. in 1914. (Rossoll remained with Gallaudet until it was absorbed by Consolidated, and was with Convair at San Diego in the mid-Fifties.) Felix became the fifth member of the Gallaudet staff; besides the brothers there were two other helpers.

In 1914, Gallaudet also completed a biplane trainer, one of the first U.S. aircraft to have a plywood fuselage; and in 1915 undertook construction of a radical seaplane, the twin-motored D-1 (see Page).

When the United States entered the war, only five American firms had produced ten or more planes in their entire history. Capital flocked to the industry as soon as international developments made it obvious that large military orders were in the wind. Gallaudet's backing came from J. K. Robinson, Jr., president of the Ox Fibre Brush Co., of Maryland. The Gallaudet Aircraft Corp. was formed in January, 1917, with Robinson as president; J. G. Crawford, an Ox Fibre executive, as general manager, and Gallaudet as chairman of the board.

A new factory was ready at East Greenwich in May; the parent company required only one boxcar to make the move from Norwich. Through the remainder of 1917, the firm worked on contracts for four Army and two Navy craft. The pace quickened in January, 1918, upon receipt of a Navy order for Curtiss HS-2 pontoon-equipped biplanes; production had reached the rate of a plane a day when the war ended Nov. 11.

Gallaudet's post-war story paralleled that of most other manufacturers. All looked in vain for development of a profitable private market. Gallaudet brought out the Chummy Flyabout, a two-seater sport machine; and the Liberty Tourist, "the last word in travel comfort, stability and beauty of outline," but the buyers weren't there. Conversion work on thousands of surplus DH-4 biplanes became the bone on which the industry gnawed. Gallaudet rebuilt four for the Air Service's first flying expedition to Alaska. (The planes left Mitchell Field July 15, 1920; arrived at Nome, August 25, and returned to a big welcome at Mitchell on October 25.) One of the company's most profitable contracts was for conversion of scores of DH-4's for the postal service.

Edson Gallaudet was especially interested in the gearing of two or more engines to one propeller, and the Navy contracted with him to design and build the power packages for its projected "Pacific" flying boat. This was to be a huge triplane having three 18-foot propellers each driven by a bank of three 400 h.p. Liberty engines. The project was later discontinued, but Gallaudet completed one power unit and shipped it to Langley Field, where it passed the 72-hour continuous run test.

At this time, the Air Service was spending as much as it could on research and development. Often the Engineering Division designed and built a prototype, then contracted with a manufacturer for one or more improved production versions. Gallaudet received several such contracts. One was for the CO-1 corps observation plane -- and thereby hangs a tale of the severest embarrassment that could befall an Army contract officer.

Engineers were turning from spruce, fabric and piano wire to metal construction in the early Twenties. The first American to design and build an all-aluminum alloy monoplane (the CO-1) was Isaac Machlin Laddon, at that time chief of Design Branch 2 in the Engineering Division (and later to have a long and successful career with Consolidated and Convair). Fleet was still in uniform when a contract for two production models was made with Gallaudet. As was his nature, he drew up an ironclad agreement.

Later, Fleet became manager of the Rhode Island firm and was compelled to meet his own requirements. According to the reports that drifted back to Laddon at Dayton, Fleet on visits to Washington went about in service circles repeating a favorite complaint: "Designed by Laddon -- expensive, by God." The upshot seems to have been a draw between the two Fleets. One aircraft was completed at a loss; the major induced the Army to cancel the contract for the second.

Edson Gallaudet had set up a business of his own when Fleet arrived at East Greenwich. He had perfected the first weatherproof tennis string, by treating silk strands with airplane dope, and was to sell thousands of yards of this product to Spalding Brothers and other sporting goods makers. ("He was a wonderful man as an engineer," Fleet has said, "but he would cheerfully undertake to build a plane with fifteen innovations, any one of which could cause failure.")

The company's directors asked Fleet to study the operation from the inside for three months, then report back. He did -- with the conclusion that Gallaudet "has nothing worthy of perpetuity or continuity, and would not bring more than $100,000 if you could find a buyer." In addition, he reported that he wanted to found a company of his own, with his own resources, and offered the directors this proposition:

"I will finish off your contracts. Since labor will lag at cutting off its meal check, I will use the men on my own work as they are available, and pro-rate the labor costs. I will charge my salary fifty-fifty to you and me. I will use materials from your stock room on my own work, at cost plus 10 per cent. For rent, I will pay you 10 per cent of my own profits, if any. Thus I will kill off your company to your best advantage while establishing my own."

The directors were deeply distressed, but decided to accept Fleet's offer. The major thereupon set about founding Consolidated, which he organized as a Delaware corporation with an authorized capitalization of $60,000 in shares of $100 par value. Actually, only $25,000 was issued; Fleet subscribed $15,000 and his sister, Lillian Fleet Bishop, $10,000. For aircraft designs and an engineer, he turned to General Motors, which had decided to close out its aircraft subsidiary at Dayton.

The Dayton-Wright Co. -- Orville Wright sold his Dayton factory and patents to the Simplex Automobile Co. syndicate in 1915, and the next year entered into a period of informal collaboration with Charles F. Kettering, inventor of the auto self-starter and owner of a fortune made with Dayton Engineering Laboratories Co. (Delco). ✓

Early in 1917, Kettering organized the Dayton Airplane Co. with three associates -- E. A. Deeds (later the head of National Cash Register); Col. Harold E. Talbott, a paper mill and power plant industrialist; and the latter's son and business associate, Harold E. Talbott, Jr. (later secretary of the Air Force, 1953-55). Wright was retained as a consultant, and the company put up a shop and hangars at South Field, near Dayton.

With additional capital supplied by a Detroit group, the enterprise was reincorporated as the Dayton-Wright Airplane Co. on April 9, three days after the United States entered the war. The elder Talbott was elected board chairman, and the younger, president; Kettering held office as vice president, and G. M. (Monte) Williams was named general manager. Deeds withdrew during the reorganization in anticipation of a government appointment. He served on the Aircraft Production Board, and in August was commissioned a colonel to serve as chief of the equipment divisfon, Signal Corps Aviation Section.

Washington decided on the basis of the Bolling Commission's report to purchase fighter craft from the Allies and confine domestic manufacture largely to training planes and the British-designed De Havilland 4, a two-place reconnaissance-bomber. The first sample DH-4 arrived from England in July, and Deeds had it dispatched to Dayton-Wright for study. Modified to accept the new Liberty engine and American machine guns, it was test-flown Oct. 29 by Howard Rinehart, Dayton-Wright test pilot.

The Army eventually contracted with Dayton-Wright for 5,000 DH-4's and 400 SJ trainers, giving the company the largest dollar volume of any aircraft manufacturer with which it dealt (see Table I).

TABLE I

Largest Army Plane Contracts, World War I*

Builder	Contract Amounts	No. of Planes
Dayton-Wright	$31,446,575.88	3,506
Curtiss	29,366,397.24	4,014
Fisher Body Corp.	19,643,837.39	2,000
Standard	15,589,694.63	1,033
Thomas-Morse	3,106,103.00	599

At the peak of operations the company employed 8,000 workers in three plants. The largest, in suburban Moraine City, used a new factory building that Delco had erected for the manufacture of lighting products. Plant 2 was opened at Miamisburg, another Dayton suburb, and Plant 3, the original Dayton factory of the old Wright Airplane Co., was used to make metal parts and fittings. When the war ended November 11, 1918, Dayton-Wright had delivered 400 trainers and 2,703 DH-4's. Post-armistice cutbacks reduced the company's final production of DH-4's to 3,111.

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*Compiled from figures in the Aircraft Year Book, 1922, Pp. 186-87.

Dayton-Wright periodically shared the news spotlight during a series of aircraft procurement investigations in 1918. U.S. production in general fell behind public expectations (only 696 American-made aircraft had reached the front when the war ended). There were widespread charges of delay, mismanagement and worse. The last of three investigations authorized by President Wilson was undertaken in May by Charles Evans Hughes and the Justice Department. Hughes conducted extensive hearings and gave his findings October 31. A frequent target of the critics had been Deeds. Hughes exonerated him of most of the accusations but did decide that the colonel, while in uniform, had acted as confidential adviser to his former associate, the elder Harold E. Talbott. Hughes wanted Deeds court-martialed. An Army board appointed through the offices of Secretary Newton D. Baker sifted the charges and concluded Deeds was blameless.*

Like other manufacturers, Dayton-Wright hoped a market for private craft would develop after the war, since the training program had taught thousands of young men to fly. The company brought out two cabin models in 1919 (to outmode what it described as "unsightly flying togs"), and displayed a small open-cockpit sports craft, the Messenger. It built a monoplane racer with retractable wheels to compete in the 1920 Gordon Bennett Cup race (see Page ____), and a float-mounted cabin plane for use in the Canadian woods. Meantime, it kept alive on Army orders for remodeled DH-4's, for Clark-designed trainers, and for 40 XB-1A night observation planes.

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* An account sympathetic to Col. Deeds is given in Marcosson, Col. Deeds, Industrial Builder, (1948), Pp. 255-304. An account sympathetic to his critic is found in Pusey, Charles Evans Hughes (1950), Vol. I, Pp. 374-82. Orville Wright's testimony at the Dayton hearing (valuable chiefly for showing the minor part he played in Dayton-Wright company affairs) is reprinted in the Wright Papers, Vol. II, Pp. 1111-1121.

Orville Wright perceived the lean years as early as June 2, 1919, when he wrote President Talbott: "The expense involved in putting the aeroplane business on a sound commercial basis will be such that small, if any, dividends are likely to come from it for some time ... I therefore herewith send you my resignation, in so far as salary is concerned, without withdrawing from any of my duties as consulting engineer."

General Motors Corp. acquired part of the company's assets and goodwill in 1919, for $1,096,000 in debenture stock, thus making Dayton-Wright a subsidiary; and took over most of the Moraine City plant for a new research center. The Dayton-Wright Co. (which lost "Airplane" from its title in 1919 reorganization) was dissolved by General Motors in 1923.

Col. Virginius Evans Clark -- In setting up Consolidated, Fleet acquired two of Dayton-Wright's principal assets -- the rights to all of its plane designs, and Col. V. E. Clark, who had been the Dayton firm's chief design engineer since he resigned from the Air Service in 1921.

Clark graduated from the Naval Academy in 1907. After two years at sea he obtained a transfer to the Coast Artillery, which he joined as a second lieutenant on October 17, 1909. He was stationed in Hawaii during construction of the Pearl Harbor dry dock defenses. Developing an interest in aviation, he was detached for duty with the Signal Corps,* and served with the 1st Aero Corps at North Island. In the latter part of 1914, he was assigned to study at Massachusetts Institute of Technology; he won the first doctor's degree in aeronautical engineering conferred by M.I.T.

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*The Army's aviation branch was born August 1, 1907, as the Aeronautical Division, Signal Corps. Name changes followed in this order: Aviation Section, Signal Corps (July 18, 1914); U. S. Army Air Service (May 20, 1918); U. S. Army Air Corps (July 2, 1926); U. S. Army Air Forces (June 20, 1941); U. S. Air Force (law signed July 26, 1947; separation from Army effective Sept. 18, when W. Stuart Symington was sworn in as Air Force secretary).

Clark was sent to Europe in June, 1917, as a member of the Bolling Commission, which made a study of the aviation activities of the Allies. Afterward, he was stationed in Dayton with the Engineering Division of the Air Service.

For Dayton-Wright, Clark designed the TA-3 and TW-3 primary trainers, which were notable for having fuselage structures of mild steel tubing, a material that proved to be rugged and reasonably cheap to fabricate. Along with Clark and the Dayton-Wright designs, Fleet also acquired an uncompleted contract for 20 of the TW-3 aircraft. Soon he and Clark were to parlay an improvement of this design into the foolproof, rugged Consolidated trainer that virtually every Army and Navy airman had for primary instruction in the decade from 1925 to 1935.

CHAPTER II

BUFFALO AND A BETTER TRAINER, 1923-27

Fleet's instinct was always to simplify designs and make the product safer. Throughout his career he carried on a running battle with his engineers, whom he regarded as lovable and indispensable fellows, but not practical.

The campaign for simplification started soon after the founding of Consolidated. Walking through the plant one day, Fleet noticed a workman scribing neat circles on a length of duralumin stock. After stopping to talk, Fleet said: "Finish what you're doing and keep tract of how long it takes. Then bring me the work, with all the washers you make when you cut out those circles."

The workman was making "lightening holes" while building a fuel tank header. The finished job of fabrication took 4 hours and 40 minutes. Fleet put the cutouts in an envelope and placed it on a postal scale; the weight saving amounted to 5-1/2 ounces. He noticed that the stock was "bastard" gage -- .042 thousandths of an inch. Inquiring further, he learned that the tank header was the only item in the aircraft for which this thickness was specified. The company had been required by the mill to place an order for 1, 200 pounds, although only 200 would be needed.

"I called in the acting chief engineer, " Fleet has related. "He was a nice young fellow, and immediately got out his slide rule and began fiddling. I said, 'Never mind, let's see what happens if we take some standard .035 stock and bend it up on a sheet-metal breaker.'

"He was back in 20 minutes with the new header. We weighed both items on the scale in the laboratory; the one without holes was two-hundredths of a pound lighter. And it was certainly strong enough. So I said, 'My boy, go all over the plant and take down your signs, "Save Weight." We're only building trainers. A little weight doesn't mean a damn thing.'"

The major was particularly indignant over the elaborate, 12-sided radiator core specified for the TW-3. It had to be built of hexagonal brass cartridge tubing, all fitted together and dip-soldered. Total cost of the first core was $564, and it leaked under a pressure of only one pound (it was required to withstand 3-1/2).

Fleet stayed at the plant one night and worked out a simple radiator of his own design, using a wood packing box for size. He cut a series of holes to let the box fit over the propeller shaft in various positions. He studied the best positioning for visibility from the cockpit, while his 10-year-old son, David, stood on a ladder and moved the box.

The shop was ordered to build a simple core to fit Fleet's pattern. This was quickly done. Under test, the core withstood five pounds' pressure without leaking. While this was going on, an engineer wrote the Air Service that Fleet was cheapening the product, and Laddon was dispatched from Dayton to investigate.

"I told Laddon that if the government wanted to go on paying $12, 500 for trainers ad infinitum, it could, " Fleet has recalled. "But this was only an experimental order for 20 planes, so why not see if we could improve things?" Laddon's investigation showed that the simpler radiator worked, and he recommended that the modification be accepted. In the same fashion, Fleet got rid of engine hoods, which were expensive to make (they required the fashioning of more than 100 louvers), and blocked the view the pilot otherwise had through the engine 'V". Consolidated trainers were built for years without engine coverings. (This was one of the reasons the cost was down to $6, 000 by 1927.)

Fleet developed one of his principles of safe construction while standing in a corn field between Buffalo and East Greenwich. He had been flying along in a trainer when the control stick suddenly jerked to one side; the right aileron was fluttering loosely. The major managed to land. Inspection showed a clevis pin holding an aileron hinge had dropped out because of a worn fitting. He noticed that the elevators and rudder, like the ailerons, were suspended by only two hinges. Loss of a pin from any one coule lead to a crash.

"I repaired the plane and managed to take off from another field, but first I went to the nearest telegraph office," Fleet has said. "I wired the plant to start using three-point suspensions on every movable control surface. Also, to fasten them with shoulder bolts, castellated nuts and cotter keys. After that, nobody ever lost a Consolidated plane because one hinge failed."

Room With A View -- The Army announced a competition for an improved primary trainer in 1923. Clark designed a simple biplane of tubular steel fuselage construction, having the cockpits arranged in tandem. (In the side-by-side TW-3, neither student nor instructor had been satisfied.) After tryouts in which five other companies competed at Brooks Field, San Antonio, Consolidated won a contract for 50 PT-1 trainers. Fleet's fledgling enterprise was strongly in business. The next move was to find quarters to fit the contract.

A supply of skilled aircraft labor was the determining factor in Fleet's choice of Buffalo. The Curtiss and Elias companies were operating there, and a residual labor pool remained from heavy wartime production. The huge North Elmwood Avenue plant that Curtiss had given up after the war offered room aplenty, and more in view for expansion (the floor space covered 31 acres).

Consolidated signed a 10-year "accordion lease" with the American Terminal Warehouse Corp. on September 22, 1924. It embraced 28,351 square feet, with option to expand if business warranted. (By 1931, Consolidated lease extensions covered 236,000 square feet.) The rent was 25 cents a foot annually, heat and watchman service included.

The first to arrive at Buffalo was not a Consolidated employe, but Lt. James Kelley, the new Air Service representative. (He would join the company in 1929, later become a director, and in World War II serve as factory manager at Convair-San Diego.) The young officer waited several weeks before Fleet drove in from Rhode Island in a Model T Ford coupe. "I remember the Model T so well, because it wasn't long until the major was driving a Stutz Bearcat," Kelley has said. Fleet at once set a crew to work unloading the three freight cars that had brought all of Consolidated's equipment, stock and records from East Greenwich.

The contract for 50 PT-1's was novel -- the trainers were to be built in increments of 10, with the first four going immediately to the Army for testing. Any modifications desired would be supplied by the contractor in the next block of 10, without additional charge. By the time the 34th trainer came off the line, Fleet received telegraphic notice from McCook Field that nothing more was wanted in the way of changes.

The Navy became a Consolidated customer in 1925 and eventually bought more than 300 planes of the NY-1 and NY-2 trainer series. These were similar to the Army PT's, but were convertible to water use with a central pontoon and wing-tip floats. The Navy employed the air-cooled Wright Whirlwind engine from the beginning. (The first 220 Army trainers had the water-cooled Wright E Hispano engine.)

Unlike the Army, which negotiated successive contracts on the basis of a single design competition, the Navy called for a new competition each time it wanted trainers -- even as few as 10. Fleet always entered these competitions personally, shipping a new demonstrator plane to Pensacola and flying down with a mechanic from Buffalo. Fifteen manufacturers entered the 1925 competition, which brought Consolidated an order for 20 NY-1's.

By the end of 1926, the company could boast in its annual article for Jane's Aircraft that C.A.C. Army and Navy trainers "have been in the air for more than 30,000 hours, and more than 600 students have received flying training in them . . . . To date no student has been killed or even injured severely enough to require hospital confinement. This safety feature is due primarily to the exceptionally well-designed and sturdy cockpit construction, which has maintained itself in the many crashes incident to primary training. So far, all accidents have been free of fire."

The article also noted that Consolidated "has maintained close personal contact with the operating personnel of both services, observing, analyzing and correcting each service difficulty when it arose." One of the first difficulties that arose after planes were sold to the Navy was corrosion. Zinc plating that stood up on land planes broke down quickly when exposed to salt water. Experimentation led to the adoption of cadmium plating where protection was most needed. Internal corrosion of structural tubing became negligible after a technique was perfected for coating the inner surface with oil, then sealing out the air with tight joints in welding.

As a rule, improvements adopted for one service were incorporated automatically in aircraft under construction for the other. "The way to stay in business with the Army and Navy is to give them your best without any holding back," Fleet has said. "Sometimes we gave them what was best before they knew it themselves."

Personnel Changes -- Col. Clark resigned as vice president and chief engineer in August, 1927. George Newman, Sr., who had been a director and general manager since the beginning, was elected vice president. Clark's place on the board of directors was filled by Ray P. Whitman, a former project engineer at McCook Field who had joined Consolidated as chief inspector in 1925. (He would serve as a vice president from 1931 to 1935, then help found a new company.) Joseph M. Gwinn, Jr., a Gallaudet engineer who had continued with Consolidated, was placed in charge of Unit I (trainer planes). Fleet established Unit 2 (heavy planes) the same year, and eventually had four divisions at Buffalo, each under an engineer who reported only to him. The title of "chief engineer" was not used again until the mid-Thirties, although this displeased the Air Corps.

"I am a strong believer in competition, not only between companies but within my own organization, " Fleet explained to his critics at Dayton. "My system induces each project engineer to make his best showing for the boss, not for just another engineer. If you've got any complaints, come to me."

Fleet believed key personnel should own a small interest in the company, thus sharing its successes and failures. In 1925 he bought half of his sister's stock holdings (originally 40 per cent) and offered these shares equally to Clark and Newman, on credit. If either man left the company later, he was to surrender his holdings at what was then the book value. At first neither accepted the offer. A little later Clark bought a six per cent interest (15 shares) for $3, 500, giving Fleet his note for that amount. Consolidated's business grew so swiftly that when Clark resigned two years later, Fleet paid him $125, 000 for these shares.

The Fifty Free Planes -- The Air Corps Act of 1926 marked a turning point for military aviation. It set up a five-year purchasing program for both services, and spurred many advances in plane and engine design.

The Army's initial appropiration would let it purchase 150 or more trainers, depending on the cost. (The price paid for Consolidated planes had declined steadily as output increased -- from $9, 800 for the first PT's to $7, 750 in the fall of 1926, and further reductions were projected.) Fleet proposed to Maj. Gen. Mason Patrick, the Air Corps chief, that a single contract for 150 trainers be negotiated. This would let Consolidated order material in quantity, maintain production without letups, and share the savings from mass production with the Air Corps. Patrick would make no commitment beyond an order for 50.

Fleet gambled on his own judgment -- "I knew nobody had a better trainer, and nobody could design a better one." He ordered steel tubing, spruce and other materials for 250 aircraft and kept the production line humming. The orders kept coming in; from the Army at intervals of 60 and 90 days, until its contracts totaled 170 planes; and from the Navy (which continued holding competitions that Consolidated always won).

By the middle of 1927, Consolidated showed a cumulative profit of $867, 000 on the service trainers it had built since 1923. The Air Corps asked to see the company's books (a privilege not yet granted by law), and followed up with a demand for a $300, 000 refund of excess profits.

Fleet and the directors felt the company had no alternative, since the services were their sole customer. Fleet negotiated one practical compromise which benefited customer and company alike, however. He pointed out that a $300, 000 payment would vanish into the general fund of the U. S. Treasury. Patrick agreed to "take it out in trade" by letting Consolidated build 50 trainers, currently priced at $6, 000 for a nominal charge of $1 each.

The Navy declined to join with the Air Corps either in seeking the settlement or accepting its proportion (26 per cent) of the plane refunds. Rear Adm. W. A. Moffett, Bureau of Aeronautics chief, replied to Patrick in a memorandum dated August 3, 1927: "The records of the Navy Department covering its transactions with Consolidated Aircraft Corp. show that all procurements from it have been subjected to competition in accordance with law...It is evident that potential competitors put forth their best efforts to obtain this business...The Navy Department is not in a position to question the profits that the company may have made."

Fleet was still protesting the justice of the settlement seven years later. In a 1934 communication to the House Naval Affairs Subcommittee, dealing with proposed regulatory legislation, he recalled the incident and said: "We took the gamble, the government did not; we should, therefore, have been entitled to the resultant savings, which would have made our profit approximately 23 per cent . . . . In 1931 and 1932 our losses to the Army put the 'shoe on the other foot,' and it would seem fair that the Army should reimburse us..."

Fleet's allusion was to losses totaling $375,157 that Consolidated suffered on Army contracts in 1931 and 32 (see Table II, listing C.A.C.'s annual sales and profits to Army, Navy and commercial customers, 1924 through 1937). Had Fleet been addressing the subcommittee a few years later, he could have cited another loss, the time on Navy business.

"Of the 49 flying boats we have built for the Navy," Fleet reported in a letter to Rear Adm. Ernest J. King in 1936, "our audited books show a total net loss of $89,673.93, with sufficient profit on the 16 built for others (i.e., commercial customers) to enable us to keep going."

CHAPTER III

THE GREAT BOOM, 1927 - 1930

From the standpoint of avid and sustained public interest, American aviation enjoyed its golden age in the closing years of the Twenties. A flourishing commercial air traffic developed in Eurpoe after the war, but at home the average American remained apathetic toward flying in all its aspects. This changed swiftly when a young air mail pilot, Charles A. Lindbergh, fired the nation's imagination with a solo flight from New York to Paris on May 20 - 21, 1927. From about that time the great aviation boom was on.

The results were spectacular: From 1927 to 1928 the number of passengers carried by air lines skyrocketed from 8,661 to 47,480, and the number of certified pilots from 1,572 to 4,887. Some 25,000 persons crowded into the Chicago Coliseum for one day's program of the International Aeronautical Exposition in December, 1928. It was estimated that up to 50,000 thronged around Cleveland airport the night of June 28, 1929, when a Stinson Detroiter flown by Byron Newcomb and Roy Mitchel landed after setting an endurance record of 174 hours, 59 seconds.

This climate was made to order for the prospering young Buffalo company, which had determined to expand into the commercial market as well as construct heavier military aircraft. Attention centered at first on the fruitless design of a bomber. The end result was a new family of long-range flying boats that were to dominate U. S. naval aviation for a decade, and incidentally spur creation of the country's first international seaplane line.

Fleet's opening move was to employ one of the Air Corps' foremost civilian engineers. This was I. M. Laddon, who joined the Engineering Division of the Air Service in 1917 and was made chief of Design Brand 2 (heavy aircraft) at McCook Field in 1919. Among Laddon's accomplishments were the GAX attack plane of 1919, and (as previously noted) the all-metal CO-1 of 1921. When the Army stopped building prototypes he turned to design details and was awarded patents in 1923 - 27 on aerodynamic, structural and equipment developments. The Bendix-Laddon disc wheel and integral brake became standard aircraft equipment in the late Twenties.

Laddon joined Consolidated in March, 1927. He remained at Dayton a year with a four-man C.A.C. field staff. (One member was C. B. Carroll, who a quarter of a century later became project engineer on the Navy-Convair experiments with the first vertical takeoff plane, the XFY-1). Fleet had optioned land opposite Wright Field for a Consolidated research and design center. He surrendered to Air Corps objections that such proximity to the center of the Army aircraft engineering would give him unfair trade advantages. Laddon's staff worked in rented quarters downtown.

What the Air Corps wanted most in 1927 was a modern, heavy (twin engine) bomber. Consolidated was one of five companies that entered a design competition, and the Dayton staff worked for some months on Model 11. This was dropped when Fleet and another competitor, the Sikorsky Manufacturing Co., reached an agreement to collaborate on a Sikorsky design.

The bomber was completed in Sikorsky's Long Island Plant late in 1927. It was a sesqi-wing of 100-foot span, powered with 525 h.p. Pratt & Whitney Hornets. It resembled the S-37 "Ville de Paris" that Sikorsky had finished earlier in the year for Capt. Rene Fonck's luckless transatlantic flight.

When wheeled out of a hangar for its maiden flight December 15, the plane bore the legend "Consolidated Sikorsky Guardian" on its red and white tail surfaces. Consolidated pilot Leigh Wade* was at the controls. After a series of tests, however, Consolidated decided the plane fell short of specifications and withdrew. (It was too late to cancel stories, pictures and advertisements in aviation publications that described the Guardian as a joint product of the two companies). The Army bomber contract eventually was awarded the Curtiss B-2 Condor.

At Dayton the Laddon staff was at work on a Navy design competition calling for a huge flying boat of more than 80-foot wingspread, to have a fuel capacity of at least 750 gallons. Rear Adm. W. A. Moffett, chief of the Bureau of Aeronautics, announced that a plane meeting these specifications would be capable of flying nonstop from the West Coast to Hawaii, a distance of more than 2,000 miles.

Laddon designed a twin-engine monoplane of 100-foot span, having an all-metal hull whose configuration derived from the Navy's transatlantic NC ("Nancy") boats of 1919. The plane was hurried to completion at Buffalo in December. Since both the Niagara River and Lake Erie were frozen, it was crated on flat cars and shipped to Washington Naval Yard for assembly.

The XPY-1 was test-flown off the Anacostia River Jan. 22, 1929. Civilian seaplane pilots were few and the Navy supplied Lt. W. G. Tomlinson to handle the controls (he subsequently broke in Consolidated Pilot William B. Wheatley.) Those aboard included Laddon, who always insisted on making the first flight in any plane of his design; Edward P. Warner, assistant secretary of the Navy for aeronautics; and Capt. H. C. Richardson, USN, a designer of the NC boats, who filled the navigator's berth.

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* Wade was an Air Corps veteran and one of the Army's famed round-the-world fliers of April 6 -- September 28, 1924. He served as vice president of Consolidated from 1928 to 1933.

The big plane "roared down the river on a 10-mile wind. . . .lifted easily after a 650-foot run, and climbed quickly," the New York Times Reported. The flight went well. Richardson told a reporter afterward: 'The boat is very stable. It felt good to have something solid under foot." Warner spoke of "a long step forward."

The Times quoted Navy officials as saying Warner hoped, in buying the XPY-1, to foster development of large flying boats for commercial lines. This proved ironical. Fleet was soon fostering a large commercial airline to develop a customer for his flying boats - - the Navy awarded the contract for nine production models of the XPY-1 to the Glenn L. Martin Co. ("They underbid us a half-million, and lost a million on the job," Consolidated men were still saying a quarter of a century later.)

The Nyrba Line -- Domestic airlines had been offered strong overseas inducements in the Kelly Foreign Air Mail Act of March 8, 1928. The Post Office Department was authorized to pay contractors up to $2 a route mile. Pan American Airways, already in the field with a Florida-Cuba service, explored routes and acquired terminal rights deep into Latin America.

This was the background against which a new airline emerged early in 1929. The promoters were Fleet, James H. Rand Jr. (of Remington Rand), and Capt. Ralph O'Neill, a World War I flier who had been aviation adviser to the Mexican Army in the mid-Twenties. It was a speculative venture at first. Fleet and Rand put up about $15,000 to finance O'Neill on an exploratory trip through South America. (O'Neill's capital consisted of a knowledge of aviation and a fluent command of Spanish.) The three were to share equally if the venture bore fruit.

O'Neill found Pan American everywhere in control along the west coast, but in Buenos Aires he was able to obtain a remarkably favorable contract. This provided that all Argentine mail destined for North America should be carried by the new line at $10 a pound, until the line was carrying one-fourth of the total of such mail. Moving north to Rio de Janeiro, O'Neill negotiated a similar contract. Pan American soon offered to buy out the three partners for $25,000 each, according to Fleet, but they agreed to turn down the offer.

In April the line's name was announced -- the New York, Rio and Buenos Aires (it became "Nyrba" for short) -- and an order for six 22-passenger flying boats was placed with Consolidated. Upon incorporation, O'Neill was elected president of Nyrba; directors included Fleet, Rand, Frank C. Munson (of the steamship line) and others. Through a public offering of stock the working capital was increased to $6,700,000.

At Buffalo, work was humming in Unit 2, housed in 68,000 feet of additional floor space leased in an adjacent area of the old Curtiss plant. The new flying boat, named the Commodore, was identical with the XPY-1 except for the hull, which was divided into luxuriously fitted passenger compartments. The first boat was launched in the Niagara River September 29. It was flown to New York (where heavy fog spoiled the effect of its flight past Manhattan) and thence to Washington. In ceremonies at the Naval Air Station on October 3, it was christened "Buenos Aires" by the President's wife, Mrs. Herbert Hoover. (The nation was dry; she broke a bottle of non-alcoholic "champagne cider" across the boat's nose.)

While Pan American pushed its service down the west coast of South America, Nyrba worked both ways from its southern terminus. Buenos Aires was linked to Santiago, Chile, with triomtored Fords in September, and to Rio de Janerio with Commodores by winter. The line had four Commodores in use and 10 on order in January, 1930, and was using 13 smaller transports on feeder routes.

During the spring and summer of 1930, several forces worked to bring about the sale of Nyrba to Pan American. Depression following the October stock market crash was ending the boom; Argentina reneged on its exclusive mail contract with Nyrba; and in government and business circles it was being argued that a single strong American operator could best meet the copmetition offered by French and German airlines. Juan Trippe, Pan American president, announced the purchase of Nyrba through a $4,000,000 stock transfer on August 21, 1930.

Nyrba had put Consolidated firmly in business as a manufacturer of flying boats, and Fleet could boast in 1934 that "Commodores have flown more than 4,000,000 miles. . .in the four years that they have been the backbone of Pan American's service." Nyrba paid Consolidated $100,000 a piece for the 14 boats, and also bought 10 Fleetster transports and 12 two-place trainers. Consolidated's profits came to $208,000, and Fleet personally wound up with a sizable block of Pan American stock.

The Fleetster -- Consolidated's second new plane of 1929 was an eight-passenger cabin monoplane, the Fleetster. It was notable as the first U.S. transport to have an all-metal monocoque fuselage. Metal techniques developed in constructing the flying boat hulls were used and it emerged as a sleek, smooth-skinned transport of ultra-modern appearance. The first ships were purchased by Nyrba for use in South America. Transcontinental & Western Air bough six, and Ludington Air Lines used some Fleetsters on its New York - Washington route (where the slogan was a flight "every hour on the hour.") In July, 1929, the press reported F. Trubee Davison, assistant secretary of war for air, would make a 10,000-mile inspection trip "in the Army's latest and fastest transport plane, a Hornet-powered Fleetster. . . piloted by Capt. Ira C. Eaker."

The Fleet Trainers -- The boom brought the private pilot into the market for the first time, and Fleet was ready. The way to sports flying had been opened by the Air Commerce Act of 1926, the first civil aviation law. It created a Bureau of Aeronautics in the Commerce Department to license pilots and planes, make safety regulations and extend the airways system. By 1929 the country had a thousand improved airports and 14,000 miles of lighted airways.

In 1928, Fleet decided to enter the sports plane field. Moving with speed and secrecy, he rented a suite of rooms in the Buffalo Athletic Club and locked himself up there with four staff members: Joseph Gwinn, engineer; George Newman, factory manager; Leigh Wade, pilot and sales director and Ralph Oversmith, material supervisor. In 2 1/2 days they finished design of the Husky Junior, a smaller, spruced-up cousin of the military trainers. Three machines were built in 26 days and flown to a Chicago aeronautical fair, where two were sold for $7,500 each.

Sales were slow for a time. The program was $174,000 in the hole by the end of the year. When the company's bankers and directors wanted to drop it, Fleet bought the rights to the Husky Junior and set up Fleet Aircraft, Inc., a sort of personal subsidiary, to handle the commercial trainer end of production. Sales of the plane, which was renamed the Fleet, were booming by the summer of 1929, and Fleet resold the rights to Consolidated.

More than 300 Fleets were delivered in 1929 and several hundred were sold at home and abroad in the early Thirties, despite the depression. At the National Air Races held in Cleveland in August, 1929, Mrs. Keigh Miller flew a Fleet Model 2 to victory in the 50-mile event for women (the runners-up included Lady Mary Heath, Phoebe Omile and Amelia Earhart). A survey in the spring of 1930 showed Fleets in use at 19 of the country's approved flying schools.

Fleet Aircraft, Inc., was kept intact as a sales agency. Its head was Lawrence D. Bell, a Consolidated vice president (and founder in 1935 of Bell Aircraft, Inc.; see Page). A manufacturing subsidiary, Fleet Aircraft of Canada, Ltd., was set up in neighboring Ontario in March, 1930. It assembled Fleets from a combination of American and Canadian-made parts, in a small new factory built on a 100-acre airport site at Fort Erie. W. J. Sanderson was named president. An early customer was the Royal Canadian Air Force, which ordered 20 trainers. The subsidiary was sold to Canadian interests in December, 1936, following Consolidated's move to San Diego. (It continued to operate under the amended name, Fleet Aircraft, Ltd.)

During 1929 the Thomas-Morse Aircraft Corp. of Ithaca, N. Y., was purchased and moved to Buffalo as Unit 4 (see next chapter). At the end of the year, the annual report showed net earning of $952,000. It was to be Consolidated's last report of strong earnings for eight years.

CHAPTER IV

THE THOMASES, 1909-1933

In the summer of 1929 Consolidated purchased the Thomas-Morse Aircraft Corp. and moved it from Ithaca to Buffalo as a wholly-owned subsidiary. This became Unit 4 of the North Elmwood Avenue plant. B. Douglas Thomas, designer of some of the most celebrated aircraft of the World War I era and vice president of Thomas-Morse at Ithaca, was made president and chief engineer of the subsidiary.

Oddly, the Thomas who came from Ithaca was no relation to the Thomas whose name appeared in the title of the firm -- William T. Thomas. Both were from England and both entered the American aviation scene a few years apart as employees of Glenn H. Curtiss at Hammondsport, N. Y.

The first to emigrate was W. T. Thomas, who came to America in 1909 following graduation from Central Technical College, South Kensington.* Thomas, then 22 years old, was a motorcycling enthusiast and had worked on gas engines during a pre-college apprenticeship with the British Westinghouse Manufacturing Co. It was natural he should seek employment at Hammondsport, where Curtiss -- holder of the world's motorcycle speed record and builder of famous racing engines -- had his plant.

Thomas got a job in the drafting room of the Herring-Curtiss Co., and soon found his interests diverted to airplanes. Curtiss had made his first flight in a plane of his own construction (the White Wing) the previous year. Thomas made drawings for the Curtiss Model K aircraft engine (4 cylinders, 40 hp) and for the Red Devil biplane used by Capt. Thomas A. Baldwin on exhibition flights.

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* This account is based on correspondence in 1956 with Mr. Thomas, now a resident of Daytona Beach, Fla.

Deciding in the fall of 1909 to design and build a plane of his own, Thomas obtained use of a Roulette Wine Co. barn and began work in November, assisted by Bert Chambers, a Herring-Curtiss motorcycle mechanic. Thomas did business as the Thomas Brothers Co., although his brother Oliver did not arrive until several months later. The company was one of the earliest all-aircraft concerns in America. (Oliver returned to England in 1913, and after World War I managed family cattle interests in Argentina, where he died in 1947.)

The first aircraft, hand-built by Thomas and Chambers, evolved as a pusher biplane with horizontal control surfaces mounted on a framework ahead of the wings (see photo). It spanned 27 feet and was powered with a 22-hp Kirkham auto engine. Chambers flew it first in the spring of 1910 at Hornell, N. Y., where the shop was moved to be near a suitable field on the Page farm. Thomas made his own first flights in June.

Late in 1910 the company moved to Bath, N. Y., and soon had eight or ten employees. This was the golden age of exhibition flying. The fledgling aviation industry catered not to government or airline but to the crowds at county fairs. The first Thomas plane was widely exhibited by Walter E. Johnson and toured the Southern states in 1911. The new Model TA of 1911 was especially successful, winning a series of races capped by the 25-mile, $1,000 prize event at the Syracuse State Fair of 1912.

Next to barnstorming the best source of revenue was teaching, and the Thomas School of Aviation, Inc. was opened in 1912, the first to be chartered by the State of New York. An early graduate, Frank H. Burnside, flew the Thomas Model E to 13,000 feet in 1913, claiming a new U. S. altitude record.

In 1912 the company was incorporated as the Thomas Brothers Aeroplane Co. (with William as president; Oliver, vice president, and Cummings M. Cox, secretary). Work continued on a new pusher design; a tractor was tried with dubious success, and several wood-hulled flying boats were built and flown from Lake Salubria.

Birth of the Jenny -- B. Douglas Thomas joined the firm late in 1914, but this came after an eventful year in which he made major design advancements in two celebrated Curtiss planes. The first was the Model J, later crossed with a sister, Model N, to become the famed JN ("Jenny") of World War I. The other was the flying boat America -- the first multi-engine aircraft built in the United States.

Thomas, born in England November 27, 1891, had entered the Vickers Sons & Maxim plant at Erith in 1907 as an engineering apprentice. He spent most of the four-year period in Vicker's aviation division. In 1912, when he was 21, Thomas took employment as assistant chief engineer with the newly founded Sopwith Aviation Co. at Kingston-on-Thames. The plant was a former roller skating rink; the engineering department occupied the old orchestra balcony.

One day in 1913 the noted American aviator, Curtiss, paid the plant a visit. He was touring British aviation establishments on a trip to Russia, where he hoped to open a factory. "I was too shy to talk with him, but I tagged along while he went through the plant," Thomas has recalled.* "He spent half the day with us."

"I rarely went to London, but that night I happened to be there. When a downpour of rain started, I ducked into a little shop on the Strand for shelter. Another fellow was waiting there, reading a paper. After a moment he lowered it, looked at me, and spoke. It was Curtiss. I was amazed that he remembered my face."

The two struck up a conversation. It developed that Curtiss was interested in building a "British-type" tractor biplane, a style to which Sopwith and other European manufacturers were turning (in America, the pusher was still dominant). Curtiss was leaving for Paris. He offered to pay the way if Thomas would accompany him to that city for further talks. The youthful engineer arranged to make the trip.

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* Interviews at San Diego, March, 1956.

The upshot was that Thomas resigned from Sopwith and began designing what became the Model J -- one of the first American aircraft of "modern" configuration (having propeller, radiator, engine and cockpit arranged on the same axis, and with the engine and cockpit enclosed.)

The winter was mild and Thomas used a tent in the yard as draftsman's office. "I had to draw the plane, stress it, and make up the whole bill of materials," he has said. "They sent me a photograph of the Curtiss OX engine to work from, but no dimensions. I had to do some guessing there. And I had to travel 20 miles to get blueprints made."

Thomas forwarded the documents to Hammondsport as work progressed. He had no settled agreement with the American, and rather expected to wind up building the plane in Russia as manager of a Curtiss factory. But he received a simple cable in April, 1914, which he recalls as reading: "Come on over. Curtiss." He sailed as soon as he could pack, and arrived in New York City May 2.

At Hammondsport he found the Model J half built, and work in progress on the Model N; the latter was a modification having ailerons mounted midway between the top and bottom wings. The "N" also employed a new airfoil section.

During the summer two Model J's were shipped to California, where the Army's only aviation unit, the 1st Aero Corps, had a field on North Island, in San Diego Bay. (This also was the home of Curtiss flying operations in the winter months). Curtiss followed and later sent for Thomas.

The planes -- allottted Army serial numbers 29 and 30 -- were a success. Curtiss announced Sept. 6 that No. 30 had been timed in a sustained flight at 85.7 mph, "the fastest biplane in America." On October 8, Capt. H. K. Muller piloted the same machine to a U. S. altitude record of 17,441 feet.

The Army had announced a competition in June for a biplane capable of 70 mph top speed, able to climb to 4,000 feet in 10 minutes, and having 4-hour endurance. If at least five companies participated, there would be $30,000 in purchase prizes. Curtiss entered Model N, which arrived from Hammondsport in mid-October. While awaiting the start of official test flights he demonstrated the plane's inherent stability by tying the between-wing ailerons to the struts, making them inoperative. The aircraft still "sped through the air at the terrific speed of 70 miles an hour, practically unguided by the pilot," reported Howard Morin wrote in the San Diego Union.

The competition was cancelled for insufficient entries but demonstrations proceeded before an Army inspection board. A biplane entered by Glenn L. Martin scored first, reaching 4,170 feet and remaining aloft 5 hours, 15 minutes. It washed out of the running November 5, however, when it crashed from 70 feet during a low-speed run. (Martin was hospitalized with severe head cuts and bruises, and his passenger, Capt. L. E. Goodier, with a broken leg and internal injuries.)

On December 7, Curtiss pilot Raymond V. Morris took Model N to 4,790 feet in 10 minutes, and on December 16 the plane was timed at 82 mph. By then, however, it was no longer a question of how good the planes were, but only of how fast they could be built. Europe was at war. Curtiss was in the east negotiating with the British; and they placed heavy orders after seeing drawings for the JN.*

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* The JN-4 and JN-6 Jennies became the most heavily produced U. S. plane of the war. Curtiss and seven other manufacturers turned out more than 6,000 for the Army. Afterward the familiar yellow biplanes were long used by military and civilian fliers. The War Department grounded its last JN's Aug. 31, 1927. In 1955 the CAA still listed four in "registered, inactive" status.

The First Big Boat -- Soon after arriving at Hammondsport from England, Thomas had been put to work on the flying boat America, which Rodman Wanamaker was financing to compete for the London Daily Mail prize of $25,000, posted for the first aerial crossing of the Atlantic. It was to be flown by Lt. J. Cyril Porte, an invalided British Navy pilot.

The 35-foot hull had been completed in May but little else. ("Curtiss had a mania for hulls. There seemed to be dozens of them stored all over the place," Thomas has recalled.) The English engineer carried out the design work on the wings, whose 72-foot span exceeded anything yet attempted in America, and on the tail, controls, fuel tankage and cockpit canopy.

The America was launched late in June and put through tests and modifications for two months. Thomas sometimes accompanies his countryman on trial runs but judged Porte to be a mediocre pilot: "Often the landing was so rough, I was afraid of being plunged through the bottom of the boat." After war broke out in late August, Porte was recalled to duty and plans for the Wanamaker flight were abandoned. Thomas joined Curtiss on the Coast, but soon after returning east went to new employment.

The Move to Ithaca -- For Thomas Brothers he designed a new biplane, the T2, an effort to improve on the J drawn for Cutiss. He joined the Bath concern as unsalaried associate, the agreement being that he would supervise construction and receive half the profits. Work began at Bath but the company transferred operations Dec. 7 to Ithaca, where the Board of Trade had offered an attractive inducement -- a year's free rent of a 3-story factory building on Brindley Street. The flying school was set up on one of the country's earliest municipal airports, a dirt runway carved through a peach orchard on the shores of Lake Cayuga.

The T2 flew in the spring of 1915. A British purchasing commission tested it and placed orders for 24. Hopes for additional sales faded, however, because of a growing shortage of the Curtiss OX engines used to power the plane. Consequently, the company on August 5 founded its own engine-building auxiliary, Thomas Aeromotor Co. Its first product was the 135 hp Thomas Model 8, a geared vee type designed by George Able and Harold Bliss, two officers of Aeromotor. Thomas designed the D2 for this power plant, and the company claimed an unofficial American speed record of 95 mph. (A contemporary volume of Jane's Aircraft pictured the D2 as the first U. S. plane to exceed 100 mph; even in those days, airplanes sometimes made their fastest times on typewriters). A pair of pontoon-equipped D2's designated Model HS were sold to the Navy in 1916.

By the latter part of 1916 it was seen that the Thomas enterprises would require additional financing if they were to remain in business. This led to organization of the Thomas-Morse Aircraft Corp. on January 31, 1917. The Morse Chain Co. of Ithaca paid off the indebtedness, put up working capital and took control as the only major stockholder. (A principal stockholder in Morse Chain was Herman H. Westinghouse, of the air brake family).

Frank L. Morse, president of the parent company, headed the new corporation. W. T. Thomas was named vice president, and the Thomas Brothers' general manager, J. A. Fried, became treasurer. B. Douglas Thomas continued with the organization as chief aircraft design engineer. Except for the post-war S-7 trainer, he was responsible for all aircraft designs produced by Thomas-Morse during the life of the company. (W. T. Thomas left the firm about 1921, and for many years devoted his time to building and flying powered model aircraft).

To handle orders that poured in after the war started in April, a reinforced concrete building known as the Hill plant was erected adjoining the chain works. The Inlet plant on Brindley Street was retained for sub-assembly work, and an experimental shop was set up in a former corset factory on Center Street.

Thomas designed a fast biplane trainer -- the S-4 "Tommy Scout" -- that won immediate Army approval. By October, 1917, the company had a million-dollar backlog: Orders for 100 S-4's at $5,400 each; 12 Navy SH-4B hydros at $7,575 each, and for a quantity of Thomas-Morse engines, on which procurement prices ranged from $4,200 to $5,274. At peak production in 1918, the Ithaca plants were employing 1,200 workers and three test pilots -- and were ordering castor oil engine lubricant in 50-drum lots. The bulk of the company's business was with the Army Air Service, to which it delivered 597 S-4's.

Next major Thomas success was the MB-3 pursuit plane, a 1918 design that was to reign as the Army's hottest fighter ship through the mid-Twenties. As a matter of policy adopted early in the war, U. S. fighter squadrons in France were equipped with Allied-made pursuits. The French Spad XIII, a single seater capable of 135 m.p.h., became the standard U. S. fighter. When manufacture of the imported Hispano-Suiza engine was started in this country, Thomas designed a compact biplane to take the 340 h.p. Hispano H motor. After testing four experimental models delivered in March, 1919, the Army gave the MB-3 an amazing official rating of 152 m.p.h. In races it was timed at more than 170 m.p.h. (see Page_____.)

A production contract for 50 MB-3's was awarded Thomas-Morse in 1919, but a major setback followed the next year -- one from which the company never fully recovered. It was known that the Air Service expected to procure 200 additional MB-3's; Thomas-Morse invested in the additional jigs and dies that would be required to fill such an order. The contract was let by open bid, however, and the order was won by the young Boeing Airplane Co. of Seattle. (In Ithaca there was a tendency to credit Maj. Reuben H. Fleet, the Air Service contract officer, for the decision to open the bidding to all comers. In negotiating the original order, he tried vainly to get the price below $13,200. After Fleet became a manufacturer and lost a flying boat contract to an underbidding competitor in like circumstances, some of the alumni of the old Ithaca company were wryly reminiscent.)

From about this time until the sale to Consolidated, Thomas-Morse remained in business as a small manufacturer whose efforts centered in pioneering the field of metal aircraft construction. As Thomas recalled it years later, "We got the jump on everybody with the S-4 trainer, then we got the jump on everybody with the MB-3. But when we tried to get the jump in metal, we were in real trouble."

One of the earliest all-metal planes built in the United States was the TM-22, a parasol-winged pursuit type produced by Thomas-Morse to compete in the 1922 Pulitzer Trophy races. It had wings of built up duralumin channel members, covered with corrugated sheet. The fuselage was fashioned of corrugated sheet laid over former rings. The rings had to be opened up or drilled to permit riveting.

America lagged far behind Europe in metal aircraft progress; neither tools nor ready-made materials were available. Thomas-Morse sometimes adapted woodworking tools to new purposes; corrugated sheets were made by running smooth stock through a wood planer fitted with corrugated rollers. In order to obtain extrusions, the company procured its own dies and lent them to the Aluminum Co. of America.

TM-22 and other Thomas-Morse ventures in metal fabrication stirred wide professional interest, but the outcome of the Pulitzer race augured ill for innovators. The two Ithaca-built racers finished 14th and 15th in a field of 15.

In 1925 the Air Corps suggested that Thomas-Morse undertake fabrication of a metal version of the new Douglas O-2 observation plane. The Ithaca firm accepted the challenge and turned out two experimental XO-6's, losing some $60,000 in process. Orders for four production models followed, and in 1928 the Air Corps ordered an XO-19, a redesigned version using fabric surfaces on wings and tail. Testing established the model's worth and a large production order was expected in 1929.

Before this came to pass, however, the parent Morse Chain Co. was sold to Borg-Warner. The aircraft subsidiary, deemed a financial liability, was omitted from the transaction and Frank L. Morse was left controlling it. On August 5, 1929, he sold the company to Consolidated Aircraft for 10,000 shares of C. A. C. stock. (The market value at the time was approximately $440,000.)

After Thomas-Morse was set up at Buffalo as Unit 4 of the Consolidated factory, work started in 1930 on an order for 70 O-19s. Additional contracts for improved versions of the observation plane boosted the final total to 170, the last delivered in 1932.

Swiftest of the Thomas metal designs -- and last to bear the Thomas-Morse name -- was the Y1O-41*, sleek sesqui-wing that reached speeds of the 195 mph when tested by the Air Corps. By then, however, the depression was in full force and Army funds were short; the plane failed to win a production order.

B. Douglas Thomas' last work at Buffalo was on the XB2Y-1, a chunky divebomber for which the Navy supplied the basic designs. He retired in July 1933 and in recent years has lived at La Jolla, near San Diego. Thomas-Morse Aircraft Corp. remained legally existent but entirely inactive until October 28, 1935, when Consolidated filed a dissolution certificate with the State of New York.

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* In Air Corps designator code, the "1" following the "Y" showed the aircraft, though undergoing service test, was a company-financed venture and involved no cost to the Government. During early testing, the designation XO-932 was used.

CHAPTER V

AUSTERITY WITH HONORS, 1930 - 35

Consolidated's history through the early Thirties paralleled that of most aircraft manufacturers in the depression years: There were exciting new developments in the art and science of aeronautics but not much to mail the stockholders. The collapse in sales did not come at once. At the end of 1930 Fleet informed stockholders the company had delivered more airplanes in number (309) and in total value ($4,345,170) than any other individual aircraft manufacturing unit in America. But he noted the net profit equaled only 3 percent of the entire volume of sales, and observed this was entirely too low for so hazaradous a business.

Consolidated sold 133 planes the next year and reported an operating loss of $177,449. The low point was reached in 1932, with sales of fewer than 100 aircraft and a loss of $318,947. Salaries and wages were cut 20 percent. Navy flying boat business and a series of foreign orders for the Fleet trainer quickened the production tempo in 1933 - 34. Governments ordering trainers included Romania (20), Portugal (5), and the Republic of China (30).

The P2Y Boats -- While the plant was finishing production of the Commodores, Laddon turned to designing an improved version of the Navy XPY-1. The 100-foot span was retained but a "sesqui" (less than half-size) bottom wing was substituted for the horizontal struts that joined hull and floats in the earlier models. Riveted alloy fuel tanks were built into the wings for a saving in weight, and there were other improvements. The Navy liked the design, Fleet leased additional floor space, and the prototype was ready to fly in March, 1932. A contract for 23 production models followed.

The long, cold winters were a severe encumbrance for a flying boat firm operating at Buffalo. The XP2Y-1 was erected outdoors on a concrete apron adjoining the ramp of the new Buffalo Marine Airport, but even in late March it was nip-and-tuck to beat the weather. A takeoff was decided upon the 26th, when wind blew drifting ice to the far side of the harbor. A hurried landing was required 32 minutes later when the wind shifted.

A fortnight later the weather was still un-cooperative. On April 14 Pilot William Wheatley, Laddon and a Navy inspector took the boat aloft with the intention of delivering it to Washington. After six hours of hither-and-yon flying in a search for a lane through the low overcast, the plane returned to Buffalo; the instrumentation and flying aids of the period made it unwise to bore up through thick weather and fly to a hidden destination.

The plane landed, but ice blown inshore blocked the ramp. Vice President Bell called Buffalo firemen, but they were unable to open a lane. The boat lay offshore at anchor until 10:30 p.m., when a passageway opened up. ("Luckily," Laddon recalled in later years, "I had a 40-ounce bottle of good Canadian whiskey along. We all came ashore warm.")

The first production models of the P2Y-1 were delivered to Patrol Squadron 10 at Norfolk in 1933. In September, Lt. Comdr. Knefler McGinnis led a squadron of six boats on the first of a series of long formation flights that attracted world-wide attention. The initial nonstop hop was from Norfolk to Coco Solo, C. Z., a distance of 2,059 statute miles; it was completed without incident in 25 hours, 19 minutes. This bettered substantially the previous world mark, set in 1931 when an Italian squadron under Gen. Italo Balbo flew the South Atlantic from Africa to Brazil, a distance of 1864 miles.

Early in January, 1934, the squadron flew north to Acapulco, Mexico (1,667 miles), and thence to San Diego (1,616), where preparations were completed for a flight from San Francisco to Hawaii. This 2,400-mile stretch of sea had been bridged several times by single planes. The first successful flight was made June 28-29, 1927, when Army Lts. Lester J. Maitland and Albert F. Hegenberger flew a triomotored Fokker from Oakland to Wheeler Field in 25 hours, 50 minutes. But the P2Y's would be attempting by far the longest overwater formation flight yet projected.

The squadron took off from San Franciso Bay the afternoon of Jan. 10 with some difficulty; the boats were heavy with 1,750 gallons of fuel each, and there was almost no breeze. They headed west through the Golden Gate (where workmen building the new suspension bridge stopped to watch) at 2:22 p.m. McGinnis and his co-pilot, Comdr. Marc A. Mitscher, led the boats through a long night of almost continuous blind flying in thick overcast. Visibility improved after dawn, and at noon the formation swept in past Diamond Head, crossed over Honolulu at 1,000 feet, and flew on to Pearl Harbor. The planes dipped their wings upon passing John Rodgers Field, in memory of the first naval officer to essay the route in 1925. (His seaplane was forced down just short of the goal; he and his crewmen were rescued unharmed by a submarine nine days later).

The lead boat alighted off Ford Island at 12:29 p.m and the last at 12:37; the elapsed time was 24 hours, 56 minutes for a distance of 2,408 miles. Territorial Gov. Lawrence M. Judd headed a welcoming committee that decorated the 30 officers and men with leis; a crowd of 1,500 persons broke through barriers to surround the ramp.

From Washington, President Franklin D. Roosevelt sent McGinnis congratulations for "the greatest undertaking of its kind in the history of aviation. . .a magnificent accomplishment." In Rome, high officers of the Italian Air Ministry expressed admiration and told the press the flight foretold the preponderant part aircraft would play in warfare.

In Tokyo, a Japanese Navy Office spokesman noted the increased power such aviation developments gave mankind, and added: "It remains to be seen whether these powers will be used beneficently or destructively."

At Buffalo, Fleet saw the flight as "ample proof that we are not far from transoceanic air transport commercially. I believe that such air lines to Europe will be in use within two years." Fleet's forecast was basically sound, although international jockeying over routes delayed Pan American's first commercial flight to Europe until July 8, 1939. In the Pacific, air mail service from the West Coast to the Philippines was launched Nov. 22, 1935, and passenger service followed in 1936.

Thank you, N.A.C.A. -- The next flying boat refinement (and additional orders) stemmed from studies Frederic E. Weick of the National Advisory Committee for Aeronautics had conducted at Langley Field. He set out to reduce the drag and turbulence created by the clutter of exposed radial cylinders in air-cooled engines. He enclosed the cylinders in a ring cowling, so arranged that cooling air entered the hood at the front and left through a smooth annular slot at the rear. When tested on an Army AT-5A late in 1928, this device produced speed improvements of 10 to 19 m.p.h.

The "N.A.C.A. cowling" quickly came into universal use; the Fleetster was one of the first transports to wear it. The N.A.C.A. studies, which were followed closely at Buffalo, showed that a cowled engine could be faired into a wing without spoiling the wing's efficiency. The last P2Y-1 in production was employed to test a Laddon modification that lifted the engines into wing nacelles. This plane was redesignated the XP2Y-2 and was given a tryout at Hampton Roads, Va. Improved performance brought Navy contracts for conversion parts to remodel boats already built (as P2Y-2s) and for 23 additional seaplanes (the P2Y-3s).

Foreign sales of the P2Y boats included one each to Colombia and Japan, and six of the dash -3 version to Argentina in 1936. This brought Consolidated's total production of PY-type aircraft (including the commercial Commodores) to 71, at a total price of something over seven million dollars.

The First Fighter -- The collapse of the boom opened the way for Consolidated's debut as a builder of Army fighter planes. The Detroit Aircraft Corp. had been organized as a holding company in 1929 to purchase several firms, including the Lockheed Aircraft Co. of Burbank, Calif. In 1931, Detroit received an Air Corps contract for a small quantity of two-place pursuits of Lockheed design, the wood-and-metal YP-24. During the same year, however, Detroit closed out most of its properties. Early in 1932 it sold its Burbank holdings to a new Lockheed Aircraft Corp., organized by Lloyd Stearman to build transports.

The upshot was that Fleet hired Robert J. Woods, designer of the YP-24, to work for Consolidated in perfecting an all-metal version of the fighter. The Army purchased two for testing as the Y1P-25 in 1932; ordered eight production models (as the P-30 and A-11) in 1933, and in 1934 contracted for 50 P-30A's. Most of the parts had been fabricated when Consolidated moved to San Diego in 1935. They were shipped to the coast and assembled there.

Moving Time -- Starting about 1930, Fleet began surveying the country for a factory site in a city unhampered by snow and ice, having public airport and seaplane facilities, and offering an adequate labor supply. Plans for a move had begun to jell by the time of a directors' meeting on May 29, 1933 (it happened to be the company's tenth birthday). The minutes show that the board heard site proposals presented in person by Emil Klicka, representing the San Diego Harbor Commission and others.

"Every month brought more and more arguements from San Diego," Fleet recalled later. Often the spokesman was T. C. Macaulay, chamber manager, who had been an instructor at nearby North Island when Fleet learned to fly there in 1917.

Finally, Consolidated entered into a conditional lease for ________ acres of municipally owned tidelands which adjoined both the San Diego airport, Lindbergh Field, and the harbor. When a final decision to make the move was reached in 1934, the company employed a West Coast architect, L. B. Norman, to draw plans for a "continuous flow" plant incorporating the best features Fleet and other officers had found in modern aircraft factories around the country. In December, 1934, directors authorized a call for construction bids, and applied for a $500,000 R.F.C. laon to help meet the expense (the loan was granted but never used).

The cross-country move was by far the largest made by a major aircraft company up to that time. Glenn L. Martin Co. changed cities in 1928-29, but only from Cleveland to Baltimore. After World War II, Curtiss was to abandon Buffalo for Cleveland, and the Texas weather would attract Chance Vought from Connecticut to Dallas, and Luscombe from New Jersey to Garland. But in the summer of 1935, it was a major undertaking to crate up 157 carloads of machinery, material and records for cross-country shipment; to pick 311 key employes whose moving expenses were to be paid. (An additional 100 paid their own way on the promise of jobs).

Bell Aircraft -- The move from Buffalo cost Consolidated several of its top executives, and resulted in the founding of a new company. Lawrence D. Bell, vice president and general manager, resigned and organized the Bell Aircraft Corp.; Ray P. Whitman, assistant general manager, remained in Buffalo to become vice president and treasurer of the new firm; and Robert J. Woods, project engineer, resigned to take a post as Bell's chief engineer.

The new firm occupied the former consolidated plant. One of its first contracts was for fabrication of outer wing panels for a new flying boat Fleet was building in San Diego. Later the company went into production on aircraft of its own design -- notably the P-39 Aircobra and P-63 Kingcobra fighters of World War II, and the Bell helicopters and experimental rocket ships of the post-war era.

CHAPTER VI

SEAPLANES AND DEFENSE, 1935-41

The San Diego plant was dedicated October 20, 1935, with a public ceremony and open house. Visitors toured an airy factory of structural steel framework; iron, stucco and glass sides, and corrugated iron roof. This afforded 247,000 square feet of space, nearly ten times that of the starting leasehold at Buffalo. The company held an option to lease 40 additional acres of municipal tidelands.

"For twelve and a half years," Fleet said in a formal address, "we have striven for this day. It marks the culmination of a dream for a factory of our own in a city of our own choice." Fleet lauded the community's people and institutions, and even the San Diego air -- "for flying it seems to have a 'body' found nowhere else." Looking to the future, he said:

"Aviation needs aeronautical engines of from 2,000 to 2,500 housepower. To develop such costs millions of dollars and years of tireless effort.... When such engines are available we expect to build gigantic flying boats that will carry a hundred passengers to Honolulu or across the Atlantic in 12 hours." (Within less than three years, Consolidated would be building the Model 31 seaplane around a new Wright Duplex engine rated at 2,000 hp.)

Fleet noted that the payroll totaled 874 employees and should increase to 3,000 by the summer of 1936. This forecast was predicated on a huge Navy order for 60 flying boats, received in June while the company was packing to leave Buffalo. The new plane would become famed as the PBY Catalina, but was still known by the designation given the prototype, XP3Y-1.

A week before the plant dedication, this newest Laddon design and lengthened the stride of flying boats by soaring nonstop October 14-15 from Coco Solo to San Francisco Bay, a distance of 3,443 miles, in 34 hours, 45 minutes. The pilot again was Comdr. Knefler McGinnis, skipper of the massed P2Y flights of 1934.

Model 28 -- The flying boat was a broad-winged monoplane, having the cleanest lines of any seaplane yet designed. A single pair of lift struts connected fuselage to wing on each side, and the tail assembly showed no external braces. Until now, fixed wing floats had increased the parasitic drag of all seaplanes. Laddon designed a retracting float that folded into places as an outer tip of the wing; thus the float actually increased lift by a small amount. Exhaust gases were utilized for the first time in a thermal deicing system; normally waste engine heat could be deflected through a system of internal ducts to warm the leading edges of wing and empennage. Finally, the Model 28 employed the first integral wing fuel tanks. Instead of building separate gasoline cells, Laddon sealed off internal sections of the wing as reservoirs. The weight saving was calculated at a half pound per gallon of fuel capacity -- a substantial additinn to payload.

The first production PBY was launched October 5, 1936, in the bay where Glenn Curtiss had made the first American hydroplane flight 25 years earlier. Meantime, Consolidated had received a Navy order for 60 additional PBY's and the factory was enlarged. This boosted production area to 543, 000 square feet, counting an enclosed paved yard where overflow final assembly operations could be conducted in the sunshine.

To finance this construction, directors authorized Consolidated's first issuance of preferred stock in 1936. Sale of 22, 976 shares at $50 realized $1, 148, 800; a block of 1,024 shares was set aside for sale to selected employees.

The clipper-hulled PBY's established themselves as the far-ranging eyes of the Navy Scouting Force with a series of mass delivery flights during 1937. The first took place January 28 when (as Time reported it) "Lt. Comdr. William McDade and 80 officers and men

of Patrol Squadron VP-6 climbed into 12 huge, low-slung flying boats in San Diego harbor, soared off without ceremony in trim formation toward Pearl Harbor, 2,553 miles away. Next morning, 21 hours, 48 minutes later, Patrol Squadron VP-6 completed its routine task without mishap."

Another dozen winged to Pearl Harbor in April, and on June 21, the first of several massed flights to the Canal Zone was conducted by a 12-boat squadron that covered 3,087 miles in 27 hours, 58 minutes.

Flights of the Guba -- For tough, workhorse dependability over a long period of years, the PBY would have few equals. This was demonstrated by the earliest commercial versions, which carried the boat's name into the Arctic and around the world. The first was built in 1937 for Dr. Richard Archbold, leader of an American Museum of Natural History expedition to Dutch New Guinea. He named it Guba, a Motu word meaning "sudden storm." After test hops to Boulder Dam and Lake Tahoe, Archbold departed San Diego June 24 on the first transcontinental flight ever staged with a flying boat. He landed at New York 17 hours, 3-1/2 minutes later.

In August, Archbold agreed to sell the first Guba to the Russian government, which was organizing a search for Soviet aviator Sigismund Levanesky, missing with his crew on an attempted transpolar flight. Sir Hubert Wilkins, the British explorer, was retained by Russia to head the search. He took Guba from New York to an operating base a hundred miles north of the Arctic Circle, at Aklavik in the Canadian Northwest Territories. Between mid-August and September 18, the seaplane flew 19,000 miles in a fruitless hunt over largely unsurveyed territory. (The aircraft eventually was taken to Russia.)

A replacement Guba was delivered to Archbold, and the transpacific flight started from San Diego June 2, 1938. Archbold flew to Pearl Harbor in 18 hours, 3 minutes; hopped to Wake Island on June 6; and on June 9-10 made a passage through unflown skies to Hollandia, New Guinea. During the next 11 months, Guba made 168 flights and carried more than 280 tons of supplies to expedition field camps in the interior. Many of the landings were on Lake Habbema, 200 miles inland and 11,000 feet above sea level.

Archbold reported that the flying boat "enabled us to do in 10 minutes work which could not have been done in two years had we used the available means of land transportation."

When the New Guinea work was nearing an end, the Australian and British government enlisted Archbold's participation in a survey of an air route across the Indian Ocean, which had never been flown.

After installation of new engines shipped from San Diego, Guba left Hollandia May 12, 1939; flew via Port Moresby and Townsville to Sydney, and thence nonstop across Australia on June 3 to Port Hedland, the jumping-off point. The survey was carried out with stops at Cocos Island, Direction Island, Diego Garcia and Mahe. News of the boat's arrival June 21 at Mombasa, on the Kenya coast, stirred interest throughout East Africa.

Heading homeward, Guba bridged Africa in two hops, lettind down on Lake Victoria and on the Congo River at Coquilhatville. On June 29-30 it made an overwater flight of 3,190 miles from Dakar to St. Thomas in the West Indies (time, 19 hours, 33 minutes). The next afternoon Guba landed at New York; Archbold and his crew were whisked off to the Aviation Building at the World's Fair for an official welcome. Guba returned to San Diego bay July 6, completing the first round-the-world flight ever made by a seaplane, and the first made by any aircraft at the globe's largest diameter.

Years of hard service still lay ahead for Guba. The British Purchasing Commission bought the boat in 1940, and on October 25 it took off from Newfoundland on a 16-1/2-hour flight to Scotland. It spent three years in Africa, flying a shuttle run for British Overseas Airways. In 1944-45 it was used as a utility plane by Saunders-Roe, Ltd. Then it was turned over to the Ministry of Aircraft Production and sent to North Wales, for several years' use in testing experimental flying boat landings; concrete blocks replaced the engines. Finally Guba sank in a gale (the year is not available), and was raised, stripped of useful equipment and sunk at sea.

The Coronado -- During early PBY production, a new flying boat was coming along. This was the XPB2Y-1, winner of a Navy design competition in late 1935 for a four-engine patrol bomber. It developed as a greatly enlarged and refined version of the PBY, a clean cantilever monoplane from which the last external bracing had disappeared. Its gross weight was 66,000 pounds, more than double the Catalina's. It could carry six tons of bombs, thrice the load of the smaller sister.

The XPB2Y-1 made her first flight in December, 1937. Nine months of testing and modification of hull and tail assembly were required before the big ship was ready to turn over to the Navy, on August 24, 1938. After the British started wartime procurement of the boat they called it Coronado, a name that came into general usage. (They already had given the PBY its familiar name, Catalina.)

The late Thirties saw the great pioneer development of transoceanic airlines by Pan American, which started crossing the Pacific in 1935 and the Atlantic in 1939. The flying boat was still queen of the seas. Not until the second World War would four-engined planes prove their dependability over long reaches of water.

Pan American stirred the imagination of designers in 1937 by inviting manufacturers to submit plans for a flying boat that could carry 100 passengers and a crew of 16 a distance of 5,000 miles nonstop. Such a boat was beyond the capabilities of power plants then available. In 1938, however, Consolidated began construction of a company-venture flying boat, the Model 31, that was planned as a commercial seaplane capable of carrying 52 passengers. It employed the unique Davis wing and Fowler flap and was the first aircraft to use the new Wright 3350 Deplex engine and a 16-foot propeller.

Toward the end of 1938, the PBY contracts with the Navy were largely fulfilled and Consolidated's payroll had dwindled from the 1937 peak of nearly 4,000 to some 1,200 workers. In December, Laddon and Charles A. Van Dusen, a Consolidated vice president, flew to Seattle to confer with Boeing Airplane Co. officials on the possibility of sharing a Boeing contract for B-17 bombers. The conferees agreed there was not enough work to divide.

But the Munich Conference had taken place in September; the picture was about to change for the aviation industry. In December, a large order from France kept the Pratt and Whitney engine plant at East Hartford from shutting down; in January, President Roosevelt urged appropiration of $300,000,000 for Army aircraft of increased range, speed and capacity; in April, Congress authorized purchase of 3,251 military planes. The great procurement program that was to reach a climax in 1943-44 was under way.

The B-24 Liberator -- Consolidated officials were called to Wright Field in January, 1939, for a conference with the chief of the Air Corps, Maj. Gen. H. H. Arnold. A long-range running mate of the B-17 Flying Fortress was needed. They were asked to produce a heavy bomber with a speed of more than 300 m.p.h., a ceiling of 35,000 feet and an operating range of 3,000 miles.*

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* DuBuque, Development of the Heavy Bomber, 1919-1944, USAF Historical Study No. 6 (1951), Pp. 80-81.

Design work started at once under direction of Laddon, and preliminary specifications were ready January 20. Mockup construction began before the end of the month. Tests of a wind tunnel model were finished and fabrication was started in February. Nearly 30 changes in the preliminary specs were agreed upon at a conference February 21 in Dayton; the Air Corps representative was Lt. Donald L. Putt, later to become project officer in development of the B-29 Superfortress.

A contract for construction of the mockup and one prototype XB-24 was signed March 30, and fabrication was well along when World War II started September 1. Wing and fuselage were ready for mating October 26, and the XB-24 made its maiden flight over San Diego on December 29.

This was a remarkable feat of design and construction -- from three-view drawing to finish four-engine bomber in less than a year. It was made possible by Consolidated's earlier gamble on the Model 31 flying boat, which was launched in May, 1939, and served as prototype for the bomber. The seaplane's Davis wing with hydraulic flaps was transferred to the bomber; so was the twin-finned empennage. The XB-24's tricycle landing gear (employed for the first time on a heavy bomber) derived in part from the company's experience with tricycle beaching gear on the flying boat.

Laddon has shared credit with the Air Corps for the bomber's swift development: "I told Hap Arnold he could have the plane by the end of the year if -- and it was a big if -- he would make Wright Field keep its hands off the project. I asked for an inspector with authority to make decisions on the spot, and he gave us a good one, Maj. E. R. McReynolds. Back in Dayton, Putt was absolutely gold-plated. He offered useful suggestions, such as a shift in engine location. And he had a very tactful way of sidetracking the high brass when they came around wanting to make changes."

We have seen that the contract for building the experimental model of the bomber was signed March 30. So great was the pressure to build up national military strength, however, that the first production order was placed three days earlier, on March 27. This called for seven B-24's. The contract grew to 46 bombers before the first test flight and rose swiftly thereafter. The French Purchasing Commission contracted for 60, with option for 120 more, in the spring of 1940; the Air Corps ordered 352 in September, and another 700 in May, 1941. (By the end of the war, the B-24 would become the most heavily produced four-engine aircraft is history.)

Meanwhile, Consolidated received a $20, 000, 000 Navy order for 200 PBY flying boats on December 20, 1939. To provide manufacturing space, an addition of 411, 000 square feet was made to the factory at a cost of $2, 470, 000; a facilities contract provided that the Government would reimburse the company and take title upon completion of construction.

Foreseeing additional orders, Consolidated launched a second expansion program in the spring of 1940. This included finaly assembly and parts assembly buildings having 645, 900 square feet of space. In November, when construction was far advanced, the company negotiated an Emergency Plant Facilities contract with the Navy, calling for reimbursement of the estimated $3, 070, 000 cost over a 60-month period.

Still greater expansion started November 16, when Consolidated signed a contract with the Defense Plant Corp. for construction of a huge government-financed parts plant on a site a mile north of the home factory, connected with it by private road and an 827-foot overpass spanning Pacific Highway. This would add 1, 593, 000 square feet of floor space; the three main buildings of what became known as Plant 2 were each 750 feet long and 450 feet wide.

Selection of the site was announced only after Major Fleet had staved off government suggestions that the plant be located in the Zone of the Interior. He consented to make a flying inspection trip to the proposed locations -- including Fort Worth, Oklahoma City and New Orleans -- but found compelling arguments against each and flew on to Washington to argue his case.

Fleet had never shied from argument with government officials, and the aviation industry's period of prewar "expansion by explosion" provided many tests of his boiling point. "They expected me to holler, and I did," he has said. His story of procuring reimbursement for the first of the Consolidated plant expansions is typical Eight and one-half months had gone by since the company completed construction and submitted its last invoice. No repayment on the $2,470,000 expenditures had come through from the Treasury Department. As a locale for boiling over, Fleet picked a Washington conference attended by the heads of the 12 major aircraft companies. The meeting had been called by Gen. William S. Knudsen, director of the Office of Production Management, to discuss the auto industry's role in aviation if the United States entered the war.

"Knudsen called on us around the table for comment," Fleet had related.* "When he got to me, I said it was obvious we would have to use the auto industry to get anywhere near all the planes we would need. But I said I thought a bigger question was whether you could bank on Uncle Sam's word any more. I told them about waiting eight and one-half months. I said if I weren't compelled to use dollar bills bearing Henry Morgenthau's signature, I'd certainly look upon them as being worthless.

"Forrestal (undersecretary of the Navy) spoke up and said, 'Don't blame Secretary Morgenthau, your invoices are all on my desk. The Navy Department hasn't worked out a procedure to pay you.'

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*Interviews at San Diego, March 1956. The same interviews are the source of all other Fleet quotations in the balance of this chapter.

"I said, 'Mr. Forrestal, you're supposed to be a business man. You've got to trust somebody. If I don't have my money tomorrow morning when we meet again, every man in this room is going to know about it."

According to Fleet, Forrestal came tohim after the conference and asked, "What would you do if you were in my place?" Fleet replied, "I'd give the chief of Supplies and Accounts ten minutes to get me a check for the whole sum. Then I'd let them audit invoices to their heart's content. If they found any errors, they could put a stop order on Consolidated for the amount." The outcome was satisfactory for Fleet, at least. He received a check for $2, 470, 000 that night.

While Plant 2 was under construction, the government rushed public housing development to accommodate workers who were being recruited throughout the country. The largest project was Linda Vista, laid out on a brush-covered mesa north of San Diego as a city within a city, having its own schools, stores and churches. Linda Vista offered quarters for 3, 000 families at first, and was expanded later.

Plant 2 was completed in the fall of 1941 and dedicated October 20 by Artemus L. Gates, assistant Navy secretary for air. At that time, the Consolidated payroll stood at 24, 000 workers (compared with 3, 170 early in 1940). It would climb to 33, 000 by the end of the year and 45, 000 in the summer of 1942.

Fort Worth -- During the fall of 1940, the War Department had begun discussion of a proposal to build three big inland plants for pooled production of the B-24. The Ford Motor Co. would fabricate parts and sub-assemblies in one, and ship these to assembly plants operated by Consolidated and Douglas Aircraft. Decision to proceed with the plan was reached that winter. The two Southern California manufacturers accepted the assignment as a matter of distasteful duty. In a telephone conversation, Douglas told Fleet, "They're turning me into the Sears, Roebuck of the industry." Fleet countered with his own complaint: "I', not happy about it, either. You can't build our B-24 without learning our heat-treatment methods and our other secrets."

The conversation turned to factory locations, and it was tentatively agreed that Wright-Patterson Field at Dayton might be suitable; the Army could use one side, and the two manufacturers could occupy plants at the far corners. The sites actually selected were Tulsa, for Douglas, and Fort Worth for Consolidated. Quoting Fleet again: "President Roosevelt decided to put them there. He told me he had made promises to the senators from those states."

The location chosen for the Consolidated plant was seven miles from the center of the city, adjoining Fort Worth Army Airfield and Lake Worth (which afforded a landing for seaplanes). The government leased 438 acres of agricultural land from the city. Consolidated contracted for the preliminary engineering and architectural studies. These were submitted to the U.S. Engineers and the general contractor, the Austin Co.

Ground was broken April 18, 1941, and construction started on a huge, air-conditioned assembly plant. This was 4,000 feet long and contained 1,991,680 square feet of floor space. The main assembly line was designed as a clear span bay, 200 feet-wide; the sub-assembly line, a clear bay 120 feet wide. (A parts plant addition added 840,000 square feet a year later.)

Since Texas was non-industrial, skilled factory workers were few. A nucleus of 1,000 men was employed in July 1941 and transported to San Diego for on-the-job training in the home factory. A division executive group was set up at San Diego, comprised largely of key men chosen from that plant. When the United States was drawn into the war in December, this group was ready to move to Fort Worth and organize a full-scale hiring program.

The engineering staff at San Diego was "split down the middle" in order to supply Fort Worth, aggravating a shortage of trained technical personnel that became acute in the 1939-41 period of defense buildup, and continued to plague the industry during the war. Consolidated had bought out the small Hall-Aluminum Aircraft Corp.* of Bristol, Pa., in August 1940 and transferred it to San Diego, largely as a means of acquiring its engineering payroll. Archibald M. Hall, formerly the president, was stationed at Fort Worth early in 1942 to superintend completion of the Texas plant. (He served later as manager of the wartime divisions at Elizabeth City, N.C., and Miami, Fla.)

Fleet Sells Out -- Reuben Fleet was only 54 and his company was expanding vastly, but he decided during 1941 to sell his holdings and retire. Looking back on this move 15 years later, he gave near-confiscatory taxes as his prime incentive. "My income in 1941 amounted to about $1,700,000," he recalled. "The federal government took 93 per cent of it, and the State of California 6 per cent. This left me $17,000. I couldn't see carrying that load of poles any longer."

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* The Hall chronology: 1920 -- Charles Ward Hall, head of a construction engineering firm, designs duralumin-framed wings for Navy seaplane HS-2L, builds them in plant at Mamaroneck. On Navy commission, designs all-metal version of TS-1 fighter; this is built as the F4V-1 by Curtiss Aircraft. 1927 -- Hall-Aluminum Aircraft Corp. organized, leases space adjacent to Consolidated at Buffalo. Builds nine PH-1 flying boats for Navy. 1932 -- Delivers XP2H-1, first Navy all-metal, 4-engine flying boat. 1934 -- Moves to Bristol, Pa.; builds XPTBH-2 twin-float, 2-engine torpedo plane for Navy, PH-2s for Coast Guard. 1936 -- C. W. Hall killed in plane crash at Hopewell, N. J.; A. M. Hall succeeds as president. 1940 -- Nine PH-3s (all-metal, 2-engine, 4-place flying boat) delivered to Coast Guard as final production before sale to Consolidated (August) and move to San Diego (September).

Fleet must have been growing restive, too, under conditions he never had been willing to tolerate: Increased "meddling" in company affairs by the defense agencies directing industrial mobilization; and loss to sheer bigness of the close, one-man direction he always wanted to exercise. (He still retained all three top titles -- chairman, president and general manager.)

His stockholdings (nearly one-third) would give any purchaser control of the company. Since Consolidated was a key producer in Army-Navy aircraft schedules, many in Washington were concerned that competent management be found. Among officials who took part in recurrent discussions of "finding a buyer," Fleet has listed Navy Undersecy. James V. Forrestal; Rear Adm. John Towers, chief of the Bureau of Aeronautics; War Undersecy. Robert P. Patterson and Gen. H. H. Arnold.

As early as July, 1941, there was a Washington-sponsored proposal that the Aviation Corp., a holding company, swing the transaction through its manufacturing subsidiary, Vultee Aircraft Corp., at Downey, Calif. Victor Emanuel, Avco president, had a four-day survey made at San Diego early in August by Vultee's top men, Harry Woodhead, chairman, and Richard W. Millar, president. Negotiations with Fleet ensued but Avco withdrew in mid-August.

There were more fruitless suggestions from Washington. In October, Fleet was considering the possibility of offering his stock at public sale. The Avco negotiations were revived soon afterward, however, and it was announced November 28 that Vultee would purchase the 440,000 shares owned or controlled by Fleet (34.26 per cent of the total outstanding) for $10,945,000. Transfer of stock was effected December 19 and the Avco-Vultee management took over.

CHAPTER VII

STINSON AND VULTEE, 1925 - 1941

The company that bought control of Consolidated in 1941 was a corporate newcomer -- only two years old -- but Vultee combined the resources of Avco with the manufacturing traditions of two established aircraft firms. The older was Stinson, founded in Michigan in 1925 by Eddie Stinson, called "the dean of American fliers." The younger company dated from 1932, when Jerry Vultee began building a fast new transport at Glendale, Calif.

Edward A. Stinson was long dead, the victim of a 1932 plane crash. When killed, the 38-year-old manufacturer had spent some 15,000 hours in the air as barnstormer, Army instructor, test pilot, commercial flier and aviation industrialist. Although he had been flying two decades, he owed his start to another Stinson who won fame first. This was his sister, Katherine, who soloed in her early teens, in 1911 or 1912,* and became a noted exhibition flier in the pre-war era of Lincoln Beachey and Ruth Law.

Eddie credited Katherine with teaching him to fly. Sister Marjorie soloed at the Wright School in Dayton in 1914 (her instructor being Howard Rinehart, later chief pilot of the Dayton-Wright Co.), and brother Jack learned, too. By 1916 the family interests centered at San Antonio, where the girls were operating a flying school. During the war, Eddie was stationed at Kelly Field as a lieutenant, serving as final checkout instructor. Between then and 1925 he operated largely out of Detroit as a professional pilot -- testing planes, carrying passengers for hire, teaching students, racing cross country with news photos.

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* The Stinsons generated legends, but few factual chronicles. A survey of the literature produces endless contradictions of time and place. This is no reflection on the Stinsons, a remarkable breed; they were making history, not writing it. Efforts to correspond with survivors and acquaintances in preparing this study were largely fruitless.

Stinson set the first of several endurance records in a gruelling flight over Roosevelt Field, L.I., on December 29-30, 1921. He and Lloyd Bertaud took off in a snow storm and circled in their Junkers JL-6 monoplane for 26 hours, 19 minutes, 7 seconds, battling zero weather and 40 mph winds. Two years later Eddie made the first nonstop night flight between Chicago and New York, also in a JL-6. This was July 26, 1923; his time for the 750-mile trip was 8 hours, 31 minutes.

In 1925 Stinson took rough designs for a new plane to two acquaintances on the Detroit Board of Commerce, Harvey J. Campbell, secretary, and William A. Mara, Campbell's assistant. With their support he organized the Stinson Airplane Syndicate. Prominent Detroiters who put money into the venture included Frank W. Blair, head of Guaranty Trust, and William E. Metzger, who was associated with early auto developments.*

Stinson rented a Congress Street loft for a factory and supervised construction that winter of a four-place cabin biplane which he named "Detroiter." It first flew January 25, 1926. Eddie claimed it was the first American plane to incorporate these features in one aircraft: Heated and sound-proofed cabin, engine starter and wheel brakes.

The syndicate led to organization of the Stinson Aircraft Corp. on May 4, 1926, with Stinson as president and Mara as secretary. Other officers were James M. Evans, chairman; Campbell, vice president, and Richard Fitzgerald, treasurer. The company obtained a two-story plant at Northville, Mich., went into production of the biplanes, and in 1927 brought out the first of the monoplane Detroiters. Sales increased steadily -- from 8 planes in 1926 to 34 in 1927, and 97 in 1928. By this time the company was offering a choice of models ranging from the four-place Stinson Junior to the eight-place Stinson Wasp.

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* From correspondence with Mr. Mara, April 1956.

Stinson had flown the pathfinder plane on Edsel Ford's first National Air Tour in 1925. Becoming a competitor himself, Eddie placed second in the 1926 tour with a biplane Detroiter, and won the event in 1927 with the first of the monoplane models. (He carried seven passengers, plus 300 pounds of rock for extra points). This brought the company note, and greater fame accrued the same summer after Eddie sold the plane to Edward Schlee and William Brock. They took it two-thirds of the way around the world, from Detroit to Europe and thence to Tokyo, in a series of flights that the press chronicled day by day.

It was a year of epochal flights, and Stinson Detroiters figured in two others. When Capt. George Hubert Wilkins (later Sir Hubert) left on his second Arctic expedition March 29, he took two Detroiters in addition to the trimotored Fokker used before. A Detroiter was in the news again October 11, when Ruth Elder and Capt. George Haldeman took off from Roosevelt Field, L.I., in an effort to fly to Paris. They were forced down at sea northeast of the Azores some 28 hours later, being rescued by a tanker. This was the year's longest overwater flight, 2,623 miles, and the two were hailed at public receptions in Lisbon, Paris and New York.

In 1928 the company raised additional capital by selling 23,500 shares of stock, and purchased a 10-acre factory site at Wayne, adjoining the Detroit-Wayne Municipal Airport. Construction started in January 1929 on a factory providing 90,000 square feet of floor space. It was ready for occupancy April 1.

The boom was nearing its climax, and in August 1929, Stinson and his associates sold a controlling interest to the Cord Corp. (This was headed by one of their oldest customers, E. L. Cord, who had owned a six-place Detroiter since 1926.) The Corman Aircraft Co., a joint venture of Cord's and L. B. Manning's, was merged into Stinson.

In 1930 the company began manufacture of the Stinson Trimotor airliner, adapted from an unsuccessful Corman design, and in 1931 Cord founded two airlines, Century and Century Pacific, which used Stinsons exclusively. Ludington Airlines also put Stinsons into service on its Washington-New York route.

The onset of the depression after 1929 depressed sales generally, but Cord met the situation head-on by drastically reducing prices; the four-place Stinson Junior dropped from $11,500 to $5,995. In 1931 the company claimed that 75 per cent of all four-place cabin ships and 70 per cent of all airlines sold that year were Stinsons.

Eddie Stinson was fatally injured in a crash at Chicago on January 25, 1932. Just after a dusk takeoff he discovered his plane was running out of gas over Lake Michigan; he had forgotten to check the gauge. He turned back in an effort to land on the golf course in Jackson Park, but his right wing tip struck a high flagpole and the machine crashed. Three passengers were injured and Stinson, the most severely hurt, died a few hours later without regaining consciousness. Many of aviation's great attended the funeral January 29 in Detroit. Two World War I aces, Edward V. Rickenbacker and Reed Chambers, were among the pallbearers. A six-plane flyover from nearby Selfridge Field was led by Maj. James H. Doolittle.

Stinson was succeeded as president by Manning, who was also a Cord Corp. vice president (and in later years a director of Consolidated Vultee). He held office until November 1934, when Aviation Manufacturing Corp., a subsidiary of the Aviation Corp., bought Cord's stock. In 1938, AMC liquidated the Michigan corporation and Stinson Aircraft became one of its operating divisions.

Airliner sales diminished after the early Thirties, and the Stinson company successfully exploited the four- and five-place cabin market with the Reliant monoplane, derived from the earlier Junior. Stinson entered the low-priced field for the first time early in 1939, introducing the three-place Model 105. In October of that year, the parent Aviation Corp. completed negotiations with the City of Nashville, Tenn., for a site adjoining Berry Field, and shortly afterward AMC began construction of a factory building to which Stinson was moved (but only temporarily) early in 1940. On October 22, Vultee Aircraft Corp. acquired Stinson as a division through a stock transfer arranged by their common parent, Avco; plans were made to expand the Nashville property for military production, and Stinson's commercial business was returned to Wayne.

Gerald F. Vultee* -- John K. Northrop resigned as Lockheed chief engineer in 1928 to found his own company. The post he vacated was given to his young assistant, 27-year-old G. F. (Jerry) Vultee, who had worked under Northrop at Douglas Aircraft in 1926, and followed him to Lockheed the next year.

Vultee engineered improvements in Lockheed's noted Vega transport and designed the fast new Sirius low-wing monoplane, in which Charles and Anne Lindbergh flew "north to the Orient" in 1931.

Lockheed was one of the firms acquired in 1929 by Detroit Aircraft Corp., a holding company organized at the height of the boom and destined to die early in the depression. After Detroit folded in 1931, Vultee obtained stopgap employment with the Curtiss-Wright Technical Institute at Glendale, just outside Los Angeles. Early in 1932 he secured E. L. Cord's backing for construction of a Vultee-designed 8-place transport, the V-1. This was a type needed by the Cord-controlled American Airways.

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* In contemporary publications, Vultee's given name appeared almost interchangeably as "Gerald" and "Gerard." The editors have not found an explanation. The form adopted here -- Gerald -- is that appearing in the records of the California Institute of Technology, where Vultee was a student in 1921-23.

Little of Vultee's story was preserved in print. The present account borrows from an article on the company, "Vultee: Up from Nowhere," appearing in Fortune for September, 1941, Pp. 80-85, 100-104.

Vultee set up shop as the Airplane Development Corp. in a small hangar at Grand Central Air Terminal, Glendale. The depression was in full force, and when American cut its 20-plane order in half, officers of Airplane Development had to scratch to find buyers for the surplus.

An improved model of the transport, the V-1A, brought prestige to the Vultee name with a series of speed and distance flights starting early in 1935. A new transcontinental record was set January 15 by James H. Doolittle (who had left the Air Corps for a between-the-wars career with Shell Oil). With Mrs. Doolittle as a passenger, he sped from Burbank to Floyd Bennett Field, New York, in 11 hours, 59 minutes; he flew entirely on instruments above a solid overcast from Colorado to Virginia.

This time was trimmed to 11 hours, 34 minutes on February 21 by Leland S. Andrews, and on March 6, the same pilot flew the transport from Los Angeles to Mexico City (1670 miles) in 8 hours, 9 minutes. As passengers he carried Vultee and his bride of two months, Sylvia Parker Vultee; the engineer himself was not yet a pilot.

The first round-trip crossing of the Atlantic was accomplished in one of the same transports in 1936 by Dick Merrill, an Eastern Airlines pilot, and Harry Richman, the actor and amateur flier. Their hedge against misfortune was something novel in flotation gear -- 40,000 ping pong balls packed into the wings of their plane, the Lady Peace. Taking off from Floyd Bennett the afternoon of September 2, they averaged 210 mph on a flight of 18 hours, 38 minutes to Llwyn Celyn, Wales. The return flight, started September 14 from Southport Beach, England, was at least a technical success; after hours of travel through stormy weather the Lady Peace made a forced landing in a swamp in Newfoundland.

With the domestic airlines converting to multi-engined transports, Vultee brought off a successful conversion of his own starting in 1936. He redesigned the transport as the Vultee V-11 attack bomber, and soon production was humming on orders from foreign governments. In April, 1936, the plant was moved from Glendale to larger quarters in the former Emsco plant at Downey, a village in the Los Angeles dairy-and-chicken belt.

The company sold 40 attack bombers to Turkey for 2-1/2 million dollars, and 26 to Brazil for $1,700,000. China contracted for one complete plane and parts for 29 at a cost of $1,000,000; Jerry Vultee traveled to the Orient to teach the customer how to assemble his ships. Russia paid $2,000,000 for nine V-11's, plus blueprints, jigs, a quantity of material and the manufacturing rights. For the first six months of 1938, the balance sheet showed a profit of $750,000.

Accompanied by his wife, Vultee left for the East on a sales trip in January, 1938. He hoped to induce the Air Corps to give the company a small, educational order for the XA-19, an American military version of the attack bomber. Flying homeward at the controls of his Stinson cabin plane, Vultee took off from Winslow, Ariz., the morning of January 29. Shortly afterward he flew into a snow storm and crashed on the slopes of Mt. Wilson, where a search party found the charred bodies next day.

Although the aircraft plant bore his name (at that time, the Vultee Division, Aviation Manufacturing Corp.), Vultee's titles were vice president and chief engineer. He was succeeded in the engineering post by his assistant, Richard Palmer, who brought forth a stream of new military aircraft designs.

Meantime, the Emanuel-Girdler syndicate had acquired Cord's stock late in 1937 for $2,632,000. Over the course of the next few years, a team of veteran industrial executives was brought in to run the company.

The first was Richard W. Millar, a West Coast investment banker and private pilot; for several years he had been a director and member of the executive committee of Douglas Aircraft. He was installed as president when Vultee Aircraft was incorporated

November 14, 1939. Then came Harry Woodhead, president of the Republic Steel subsidiary, Truscon Steel; he resigned from Truscon to take the presidency of Aviation Manufacturing Corp. in April, 1940, and in August left that post to become Vultee board chairman. He was elected president of Consolidated in December, 1941, and of Vultee in 1942, after Millar resigned.

Charles W. Perelle, who had been Boeing Aircraft production manager, was made general manager at Downey. Just after the war started, an executive who had been absent from the aircraft scene for 20 years became vice chairman of the Vultee board. This was G. M. (Monte) Williams, general manager of the Dayton-Wright Airplane Co. in World War I. (During the intervening years, he had served successively as president of Wire Wheel, Marmon Motor Car and Russell Manufacturing.)

The company received its first Army order in the summer of 1938 -- for seven V-11 type attack bombers, designated the YA-19. This was the fruition of Jerry Vultee's salesmanship, and Engineer Palmer hailed the contract with an article in the plant magazine, the Vultair. "Performance of this contract will be a liberal education, with the Air Corps as teacher," he wrote, "and if we earn a diploma pasted with gold stars, we pass to the next grade -- future orders. Personally, I haven't the slightest doubt that every man will bust his ankle to accomplish this."

In time, the directors may have wondered whether it was necessary to bust the bank account, too. The company lost $60,000 on the YA-19 contract. Millar then entered eight military design competitions in a row -- running the cumulative engineering losses to nearly a half million dollars -- without scoring a success.

Deciding to concentrate on training craft, the company made an all-out effort when the Army announced a competition for an advanced trainer. Palmer and his staff moved their beds into the plant and worked around the clock. From first sketches to test flight, the XBC-3 was completed in 88 days. This time the Army bought the plane, for the bare cost of $191,000, but awarded a production contract to North American.

"It was tough to take," Millar recalled afterward. "Our hearts and souls went into that plane."

The payoff finally came in August, 1939, when Palmer's design for a basic trainer won a whopping contract for 300 BT-13s. This was to become the standard basic trainer of World War II. By the time the first production order was finished in the winter of 1940, Vultee was tooling up to turn out 300 trainers a month; wartime production finally reached a total of 11,537.

As a counter to the German Stuka, Palmer designed for the British a dive bomber that brought orders aggregating $90,000,000 in 1940-41. This was the Vengeance, designated A-31 and A-35 by the U. S. Air Force; it was christened by Lady Halifax, wife of the British ambassador, in ceremonies at Downey in the summer of 1941.

Palmer's design for a fighter, the P-66 Vanguard, won an $11,600,000 order from Sweden in February, 1940.

At Nashville, Stinson was building L-1 liaison planes for the Air Corps in a new plant put up by AMC. When Vultee acquired control late in 1940, the factory totaled 180,000 square feet. Millar immediately began an expansion program that increased space to 817,000 square feet by the fall of 1941. Production of the dive bomber was shifted to Tennessee and Stinson resumed operations in the Michigan factory.

Expansion was the order of the day at Downey, too. Vultee's home plant had 133,000 square feet of space early in 1938, when the only work in hand was the V-11 attack plane (and the working capital at one point was a deficit of $175,000.) By May of 1940 (when President Roosevelt asked for production of 37,000 military planes in the next 18 months), the factory had grown to 325,000 square feet. By 1941 this figure was more than tripled -- 1,008,000 square feet.

The first powered final assembly line ever used in an aircraft plant was put in operation at Downey in May, 1941. It was planned by Don I. Carroll, Vultee vice president for production, and General Manager Perelle. The system featured 25 cradles riding on an oval overhead track. Raw fuselage frames carried in the cradles passed through 25 assembly stations to receive electrical systems, cockpit enclosures, instrument panels and the like.

Leaving the track 40 hours later, the frame was ready to receive such major subassemblies as power packages, tail assemblies and wing center sections. Fortune reported that the powered line and other changes had cut final assembly time on trainers 75 per cent, and reduced costs an estimated 40 per cent.

Additional conveyor systems were installed, two of them reaching all the way through subassembly departments into fabricating divisions. Powered final assembly lines later were installed at Nashville, and adopted by Consolidated at San Diego and Fort Worth, and by Ford at Willow Run.

Along with powered lines, Vultee also pioneered in the employment of advanced machine processes. Production time on wing ribs for the trainers was cut from 16 hours to 5 when Minster crank presses, using accurate steel dies, were substituted for drop hammers. An automatic rivet gun and bucking bar, yoked and suspended from a counterbalance, enabled one woman to accomplish the work formerly done by two men. Steel tube fuselage sections were finished nearly 12 times as fast after development of a master milling and drilling fixture.

By the fall of 1941, Vultee was employing nearly 10,000 workers at its three divisions (Downey, Nashville and Wayne), and had a backlog of $178,000,000 in domestic and foreign military orders.

The purchase of Fleet's Consolidated stock, contracted for in late November, brought about a near-merger of the two companies under the direction of Aviation Corp., which owned 71 per cent of Vultee Aircraft and hence controlled both organizations. Tom M. Girdler was granted part time leave from Republic Steel to serve as board chairman and chief executive officer of the companies. Under him as president of both was Harry Woodhead.

At San Diego, I. M. Laddon became executive vice president and general manager of Consolidated, and was elected a vice president of Vultee. David G. Fleet, Consolidated director (and son of the founder) was shifted to Downey as Vultee executive vice president in 1942.

To finance the purchase of Maj. Fleet's holdings, Vultee sold 240,000 shares of preferred stock to underwriters, for $5,430,000, and 150,000 shares of common stock to the parent Aviation Corp. for $1,500,000. The company obtained an additional $2,350,000 from current funds or increased bank loans, and gave Fleet a promissory 3 per cent note for the remainder, $1,665,000. This was payable in cash or stock by June 30, 1942.

The mechanics of merging the corporations were worked out during 1942, and in January 1943, directors of both approved a form of agreement having these main points: Consolidated would be the surviving corporation, its name changing to Consolidated Vultee Aircraft Corp.; Consolidated's common stock would remain outstanding as CVAC common; each share of Vultee common stock would convert to 45/100 of a share of CVAC common, and Vultee preferred would become CVAC preferred. (Additional details will be found in the appendix, page ____.)

Stockholder meetings approved the proposal March 17, 1943, and it became effective when articles of incorporation were filed in Delaware the next day. The boards of directors were merged and the top executive team continued to be Girdler and Woodhead, with Laddon as executive vice president.

CHAPTER VIII

THE WARTIME GIANT

When the attack on Pearl Harbor drew the country fully into war in December 1941, the airframe industry was far advanced on its first phase of expansion, the enlargement of plants already in existence. Consolidated's payroll, only 6,000 when President Roosevelt called for production of 50,000 planes a year in May 1940, had passed the 30,000 mark. Vultee Field's work force had grown from 2,500 to 6,000. The year 1942 brought the expanded plants into full production and saw the completion of such new facilities as Consolidated-Fort Worth and Ford-Willow Run.

As the production tempo mounted, problems of manpower, materials and general congestion multiplied. For the overgrown Southern California aircraft industry, additional expansion had to be achieved elsewhere -- by establishing a modification center in Arizona, or converting an empty Pennsylvania truck factory into an airplane manufacturing plant. After the formal merger of Consolidated and Vultee in March 1943, Convair comprised a structure of 13 manufacturing, modification, research and operating divisions in 10 states; the combined payroll reached a peak of 101,637 late in 1943.

San Diego Division -- Among all Convair plants, the big home factory at San Diego was the heaviest producer. In the period from January 1, 1941 through September 30, 1945, San Diego delivered 235 million pounds of aircraft and spare parts. This amounted to 8.2 per cent by weight of the entire output of some 70 U.S. and Canadian plants that manufactured aircraft for the Air Force, Navy and Allied governments during World War II.*

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*Derived from analysis of statistics in U.S. Military Aircraft Acceptances, 1940-45 (CAA Office of Aviation Information; Washington, 1946; 204 Pp.)

By the summer of 1942, Chairman Tom Girdler had pushed San Diego's potential well beyond the government's ability to supply parts and materials, Fortune reported in September. "This has been the result of introducing a straight-line production system, of pushing more and more of the final assembly back into the subassemblies, of patient worker education, of introducing incentive bonuses, and of delegating authority," the magazine said.

Peak output was reached in January 1944. During that month, the assembly lines delivered 253 Liberator bombers, 74 Catalina flying boats, and the first production model of the four-engine Coronado flying boat.

Employment at San Diego remained close to 45,000 from the summer of 1942 through April 1943. It dropped slowly to 35,000 over the next two years, then beginning in May 1945 shriveled away until only 6,760 remained on the payroll at the end of the year.

Fort Worth -- A skeleton administrative staff trained at San Diego had returned to Texas in December 1941, and the new plant opened officially on April 17, 1942, with a backlog of $158,000,000. This was for the assembly of 600 B-24D bombers that Ford was to ship as knock-downs from Willow Run. Since the Ford plant was not yet in production, it was arranged for San Diego to send components for 150 bombers.

The first assembled Liberator was accepted by the Air Force on May 1, 100 days ahead of schedule. Thereafter B-24s and C-87s (a transport modification of the Liberator) poured off the assembly line for more than 2-1/2 years. Production exceeded 200 planes a month in the winter of 1943, employment reaching a peak of 30,574 in November of that year.

In August 1942, the Texas division received a historic assignment, responsibility for detailed design and construction of two XB-36 intercontinental bombers. (Preliminary design and mockup had been completed at San Diego.) The B-36 project retained low priority as long as production emphasis remained on current combat types, however. The prototype was nearing completion when the war ended (see Pp.).

Fort Worth's second collateral contract was for production of the B-32 Dominator, a heavy four-engine bomber fostered by the Air Force as a counterpart of the Boeing B-29. Production began in January 1944, and the first B-32 was accepted by the Air Force September 15, 1944; the following April the first 15 planes were assigned to Western Pacific duty. The Pacific campaign had been progressing so faborably, however, that the B-32 program was cut back heavily in May. (A more detailed account of the B-32 is given in the technical section, Pp. .)

Fort Worth had produced more than 3,000 multi-engine aircraft when termination orders on the last wartime contracts were received August 15, 1945. By December, the payroll had shrunk to 6,200 workers, engaged principally in the XB-36 program. John O. Lockwood, of the Contracts Department, concluded preparation of a division history at year's end with this parting touch of sentiment and prophecy: "Having contributed immeasurably to winning the peace, Fort Worth Division of CVAC continues to produce airplanes that will contribute toward maintaining the peace!"

Vultee Field -- At Downey, the Vultee Field Division (as it was called after the merger) concentrated through 1944 on production of Valiant trainers -- BT-13s and -15s for the Air Force; SNV-1s and -2s for the Navy. During the winter of 1941, Vultee also turned out 144 P-66 fighters, ordered originally by Sweden in 1939, but finally diverted to China.

Employment reached a peak of 7,748 in November 1943. After trainer production stopped in 1944 (the last deliveries being made in June), the division turned to manufacture of components for planes produced by sister divisions -- B-24 and B-32 bombers, PB4Y-2 patrol bombers and P-38 fighters. The engineering staff in the closing months of the war undertook a series of radical design studies that led to development of the first delta-wing aircraft, and some of the guided and ballistic missiles of the mid-Fifties; these are more fully treated in Chapters and , below.

Stinson, Stout -- The Vultee Aircraft division at Wayne, Mich., shifted from commercial to military production during 1941, and in 1942 began delivering two types that remained its wartime specialties. First and most famed was the L-5 Sentinel, a nimble little liaison plane that came to be known around the world as the "Flying Jeep." Production of L-5s totaled 3,598.

The other aircraft was the At-19 Reliant, a lightened and simplified version of the commercial Reliant, Stinson's best-known product of the middle and late Thirties. Wartime production totaled 500 AT-19s, most of them made for delivery to the British, who used the Reliant as a trainer for navigation officers. Employment at Wayne reached a maximum of 1,989 in July 1943.

A small, second Michigan division was established at Dearborn late in 1942 when Consolidated took over the Stout Engineering Laboratories as a research center, largely for development of possible post-war commercial designs. Chairman Tom M. Girdler announced in December that William B. Stout, the veteran aircraft engineer and inventor, had been engaged to devote his full time to this project.

Stout was a man of many innovations, a pioneer in thick-winged momoplane and metal aircraft design. He developed the Ford tri-motored transport of the Twenties, brought out the first of a series of midget "sky cars" in 1931, and also turned his talents to designing new autos, a "railplane" for the Pullman Co., and folding houses. Activities at Dearborn during the war centered in development of light vehicles designed for convertible use as either planes or autos.

Nashville -- One of the largest manufacturing divisions was Nashville, where a factory for Stinson had been built in 1940 by the parent Aviation Corp. Several hundred commercial craft were produced there by Stinson. When Vultee Aircraft acquired Stinson as a division in the fall of 1940, manufacture of commercial planes was returned to the old Stinson factory in Michigan, and Vultee created a Nashville division to produce aircraft in the Tennessee plant, which was greatly expanded.

Nashville turned out Stinson-designed L-1 Army observation planes through early 1942, while tooling up to make the Vultee Model 72 dive bomber (bought by the British as the Vengeance, and by the Air Force as the A-31 and A-35). The first dive bomber was delivered in March 1942, and employment reached a high point of more than 6,500 in December 1943, when production was nearing maximum.

The Vengeance program was phased out in the spring of 1944, with final production totaling 1,539 dive bombers. The plant was converted to making components for the Lockheed P-38 fighter, and finally to assembling complete P-38s; the first Lightning was accepted in January 1945. Production stopped in June.

New Orleans -- Early in the war, plans called for Nash-Kelvinator to make Vought-Sikorsky flying boats in a government-built plant on Lake Pontchartrain, New Orleans.

This program was abandoned late in 1942, and the Navy announced in January 1943 that Consolidated would take over the factory, then nearing completion, to build P4Y flying boats (the Consolidated Model 31). Tooling was started that spring, but plans changed anew; the P4Y project was dropped and it was decided to transfer manufacture of PBY-5A Catalina amphibians from Convair-San Diego to Convair-New Orleans.

The first Catalina was accepted by the Navy in April 1944, and production totaled 235 through September 1945. (Into these boats went 119 hulls and 172 wing center sections shipped from Montreal by Canadair Ltd., a newly founded Canadian company that later became a subsidiary of General Dynamics.) The New Orleans Division reached a peak employment of 6, 487 in February 1945. The plant was closed in September, and the property returned to the government.

Allentown, Miami -- The Navy proposed in 1942 that Vultee Aircraft undertake manufacture of a Vought-Sikorsky torpedo bomber, the TBY Seawolf. In December it was announced that the Mack-International Motor Truck Corp.'s Twelfth Street plant in Allentown, Pa., would be taken over for this purpose; the Defense Plant Corp. would spend an estimated 11 million dollars for machinery, auxiliary buildings and an airport. Production started in August 1943, the first TBY was accepted in November 1944, and employment climbed to 4, 990 in the spring of 1945, when the torpedo bomber began coming off the assembly line in quantity. Cutbacks held final production to 200 planes, the last accepted in September.

The Miami Division grew out of the Vultee Aircraft's purchase in July 1942 of a small Florida aircraft parts company, Intercontinent Aircraft Corp., * of Miami Springs.

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*Intercontinent was organized in 1940 by William D. Pawley and Comdr. Bruce Leighton; in 1942 the plant was under direction of W. S. Laycraft, executive vice president, and R. E. Brown, works manager. Vultee directors authorized the purchase for $650, 000 on July 16, 1942.

G. M. Williams, vice chairman of the Vultee board, was made president of this subsidiary, and another Vultee official, Don I. Carroll, was appointed executive vice president.

Intercontinent manufactured various military products, including components for Convair B-24s and A-35s, Vought F4Us and the Lockheed P-38. The subsidiary corporation was merged into CVAC as a division in April 1943; after the war it was closed and the property disposed of.

Modification Centers -- On the basis of his observations in England in 1941, Maj. Gen. George H. Brett recommended that the Army Air Force set up modification centers, where minor alterations could be made in aircraft without slowing assembly line production of basic models. (Over the next four years, experience would show that nearly 100 per cent of bombers, and 50 per cent of other types, would require some degree of modification after leaving the factory.)* The Materiel Division proposed in January 1942 that 10 such facilities be set up.

The first Consolidated center was opened in May at Tucson, 400 miles inland from San Diego, and initially was called a "dispersal base." It was organized as a division in August 1942, reached an employment peak of 4,285 in February 1944, and handled a total of 4,103 aircraft through September 1945.**

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*Toole and Ackerman, Modification of Army Aircraft in the United States, 1939-1945, USAF Historical Study No. 62.

** Modification center production data:
Fort Worth -- First plane received July 20, 1942; last delivered Oct. 7, 1943. By years: 1942--208 units (B-24s). 1943--646 (B-24). Total -- 854.
Louisville -- First plane in Sept. 28, 1942; last out Aug. 29, 1945. By years: 1942--5 (A-31). 1943--457 (A-31, A-36, B-24). 1944--1,054 (A-31, B-24). 1945--564 (B-24). Total -- 2,080.
Nashville -- First plane in March 21, 1944; last out Sept. 11, 1944. Total 196 (A-35, P-38). (Work undertaken as a fill-in during slack production period.)
Tucson -- First plane in Nov. 30, 1942; last out Sept. 6, 1945. By years: 1942--2 (B-24). 1943--2,008 (B-24, C-87, P-51). 1944--1,946 (B-24, C-87, F-7, P-51). 1945--147 (B-24, F-7, P-38, B-29). Total -- 4,103.

The Tucson facility, using an area adjoining the municipal airport, employed as many as six assembly lines on such jobs as installing improved gun turrents, fitting droppable fuel cells, or meeting a theater commander's request that the positions of navigator and radio operator be switched in B-24s assigned to him.

Vultee Aircraft opened a center at Louisville, Ky., in the summer of 1942. It specialized in modifying B-24s and A-35s, had a top employment of 2, 214 in March 1944, and closed in September 1935. (For a time the Fort Worth Division operated a modification center separate from the factory, but this was closed and the work diverted to Louisville in October 1943.)

In the winter of 1942, Consolidated established a center at Elizabeth City, N.C., to modify naval aircraft -- PBY Catalinas, PB2Y Coronados and North American PBJ's. (Here a housing crisis was alleviated by anchoring a floating hotel offshore. This was the 75-room Amphitrite, and old East Coast resort attraction.) Elizabeth City's peak payroll was about 1, 200 in December 1943. The center was closed in September 1945.

Consairway Division -- At the time of the attack on Pearl Harbor, the country's entire inventory of four-engined transport planes totaled 27 aircraft. These ranged from eight Boeing Clipper flying boats in the service of Pan American Airways, to 11 converted B-24s used by the Air Corps Ferrying Command. The problem of overseas air transportation was crucial for months.

In April 1942, Maj. Gen. H. H. Arnold decided to open a regular service between the mainland and the Southwest Pacific with two repossessed LB-30's (British designation for the Consolidated Liberator). The Ferrying Command selected Consolidated Aircraft as the logical operating agency.*

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*Craven, Army Air Forces in World War II, Vol. 1, Pp. 352-53, 359-60.

The San Diego company had a pool of transpacific pilots, built up when 14 crews were trained to deliver PBY's to the Netherlands East Indies in the summer of 1941. Richard A. McMakin, head of the company's Flight and Service Department, was picked to direct what became the Consairway Division. He conducted a 14, 600-mile pioneering survey of the California-Australia route between April 2 and 8, 1942,* and the first regular flight started April 23. It took off from San Diego with a ton of radio and plane parts, and mail. The transport returned 11 days later with a passenger list that included 22 Ferrying Command pilots.

Later, headquarters of the transpacific line was established at Hamilton Field, in north-central California; some 1, 500 persons were transported from San Diego to Fairfield to set up the new division. Four planes were added to the service in June, and the airway achieved heroic results in the face of hazardous and primitive conditions. One early rush job was airlifting a 500-man pursuit group to Australia. Priority cargo ranged from aircraft parts to four 2, 000-pound torpedoes, complete with warheads.

In August, Consairway began carrying United Air Line captains as crew members, to familiarize them with the route. United opened a second contract service over the airway in September. Consairway's first full-fledged overseas base was built in October at Amberly Field, Australia, by the Air Service Command. The basic route touched at Hawaii, Christmas and Canton Islands, Fiji and New Caledonia. With progress of the war, a new western terminus was established on northwestern New Guinea.

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*For the survey flight, McMakin was awarded the Air Medal posthumously. (He was killed in an XB-32 crash at San Diego on May 10, 1943.)

By 1945, the line had 17 Liberator transports in service. During May they averaged 15 hours, 11 minutes of flying time daily. Seven transports had more than 10,000 hours of flight.

The line's record round trip was California to Australia and return in 3 days, 17 hours. For a one-trip cargo-carrying record, Consairway pointed to Liberator No. 568, which lifted a payload of 10,317 pounds from Fairfield to Hawaii on April 20, 1945, and continued southwestward with loads of more than 10,000 pounds on each of its next three stops. When the airline closed December 15, 1945, Manager Rogert S. Mitchell reported it had carried more than 101 million ton-miles of cargo, and had flown more than 299 million passenger miles.

Feeder Shops -- Subcontracting accounted for only 10 to 20 per cent of the airframe industry's output in 1940, but manpower and space shortages brought broad changes starting in 1942. By 1943, Convair-San Diego was building B-24's with parts received from nearly 100 subcontractors, fabricating such normally factory-made items as horizontal and vertical stabilizers and bomb bay doors. At Convair-Fort Worth, it was estimated 40 per cent of fabrication on bombers and transports was performed by subcontractors, who shipped a million pounds of parts to the plant monthly.

Feeder shops, another means of "taking the work to the laborer," came into widespread use. The system was inaugurated at Convair-San Diego in December, 1942. By early 1944, the plant had a network of 11 feeder shops in California cities up to 130 miles distant, employing 1,700 workers (of whom 90 per cent were women).

Headquarters of the system was in Santa Ana, where three shops were situated. Raw materials were distributed from there, and finished parts collected for delivery to

San Diego. Typical feeder shop products included bulkheads, electrical harnesses, sheet metal sub-assemblies, plexiglass moldings, and most of the upholstery going into B-24's. At Coronado, one shop specialized in sorting rivets swept up from plant floors.

Summary -- Convair out-produced all over aviation manufacturers in 1943 as judged by either of the production yardsticks, airplanes delivered or poundage (including spare parts). The leaders that year in each category:

Total Planes		Weight, Millions of lbs.	
Convair	10, 496	Convair	128.7
North American	9, 106	Douglas	118.1
Curtiss	6, 611	Boeing	73.9

Over the five-year period 1941-45, the airframe industry produced 2.85 billion pounds of planes and spare parts. Convair held second place among the five leaders:

Company	Millions of lbs.	Pct. of Total
Douglas	435.5	15.2
Convair	372.6	13.0
Boeing	344.7	12.0
North American	292.8	10.2
Lockheed	246.8	8.6

During the same five-year period the industry delivered 296, 252 finished planes. Convair also held second place in this category:

Company	Planes	Pct. of Total
North American	40, 644	13.7
Convair	30, 687	10.3
Douglas	30, 433	10.2
Curtiss	25, 373	8.5
Boeing	17, 949	6.0

The editors have found no breakdown of the dollar value of wartime contracts within the airframe industry. The following compilation,* however, shows how the defense dollar was divided among top industrial contractors of all types in World War II:

Company	Pct. of Total
General Motors	7.9
Curtiss-Wright	4.1
Ford Motor Co.	3.0
Convair	2.8
Douglas Aircraft	2.5
United Aircraft	2.2

Thus the end of the war found Consolidated Vultee in strong position among the leaders of what had become, since 1938, a strong industry indeed. But ahead lay reconversion.

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*From War Production Board figures as tabulated in Modely, Aviation Facts and Figures, 1953, P. 21.

TABLE XXX

Wartime Production of Convair Plants*

Division	1940	1941	1942	1943	1944	1945	Total
Allentown, Pa.							
TBY	--	--	--	--	2	178	180
Vultee Field							
BT-13, -15, SNV	232	1, 841	4, 132	4, 049	1, 283	--	11, 537**
P-66	--	71	73	--	--	--	144
V-72 (A-31)	--	--	1	--	--	--	1
XP-54	--	--	--	1	--	1	2
Fort Worth							
B-24	--	--	9	1, 123	1, 611	--	2, 743
C-87	--	--	41	105	140	--	286
AT-22	--	--	--	5	--	--	5
B-32	--	--	--	--	14	100	114
Nashville							
L-1	1	171	152	--	--	--	324
A-31, A-35	--	--	493	766	270	--	1, 529
P-38	--	--	--	--	--	113	113
San Diego							
LB-30, B-24, Etc.	6	169	1, 123	2,345	2,450	631	6, 724
PB2Y	1	4	39	130	41	--	215
PBY-5	21	395	729	627	175	--	1, 947
PB4Y-2	--	--	--	--	286	453	739
RY-3	--	--	--	--	4	29	33
B-32	--	--	1	2	--	--	3
New Orleans							
PBY-5A	--	--	--	--	51	184	235
Stinson							
AT-19	--	--	2	230	268	--	500
L-5	--	--	18	1, 116	1, 361	1, 103	3, 598
YO-54	6	--	--	--	--	--	6
TOTALS	267	2, 651	6, 813	10, 499	7, 956	2, 792	30, 978

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*Compiled from Aircraft Acceptances, previously cited, with minor differences (such as inclusion of 3 B-32s in the San Diego production). One rarely sees two sets of wartime production figures that agree exactly. For uniformity, the one source is used for all production data in this chapter, except as noted.

**A total of 13, 740 is sometimes seen for the BT-13/SNV trainer series. This includes "equivalent spares, " a legitimate measure of overall production, but not of numerical plane deliveries.

CHAPTER IX

COMBAT STORY: THE CATS AND LIBERATORS

Two Convair combat planes were produced in volume during the war -- more than 2,000 PBY flying boats and 18,000 B-24 bombers. They served with distinction in every American theater.* In this chapter we recall briefly the highlights of their global war story.

The Catalina combat diary began a few minutes after sunrise Dec. 7, 1941 when a patrolling PBY sighted the periscope of a Japanese midget submarine off the entrance to Pearl Harbor. At 6:33 a.m. the pilot, Lt. William P. Tanner, dropped smoke pots to mark the spot, and a few minutes later the destroyer Ward attacked and sank the vessel. This was the Pacific Fleet's opening action of World War II.

The few PBY's that were aloft that Sunday morning were lucky. Of 36 stationed at Kaneohe Bay, only three on patrol escaped the Japanese air attacks starting at 7:55. Twenty-seven were destroyed and six damaged.

In the Philippines the advent of war was not much happier. The eyes of the Asiatic Fleet consisted of 28 Cats in Patrol Wing 10 (Capt. F. D. Wagner), based on the tenders Langley and Childs at Manila Bay and Olongapo; and four at Davao mothered by the tender William B. Preston. In the first few weeks, 25 were expended in gallant efforts to stem the Japanese invasion.

Soon evacuation became a principal occupation of the flying boats. On Dec. 24 two PBYs ferried Maj. Gen. L. H. Brereton, commander of the Army Far Eastern Air Force, and his staff to Australia. Such flights continued in the following months. On April 30, only a week before the final surrender, two Catalinas made a hazardous trip from Australia to take off some 50 persons -- key officers of Gen. MacArthur's staff, and Army nurses. One boat was wrecked and another damaged in landing at Mindanao. Crewmen of the second aircraft succeeded in patching most of the hull, then "with true American resourcefulness, they placed the plumpest nurse directly over the largest remaining leak and so managed to take off for Australia."*

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* Both planes saw action with the British prior to Pearl Harbor, and with several of the Allies, but the present narrative is confined to U. S. action. Perhaps the most celebrated British PBY was a Coastal Command Catalina that found the German battleship Bismarck 550 miles west of Land's End on May 26, 1941, some 24 hours after she had given the slip to a Royal Navy surface force. Attacked and driven off, the PBY passed the word that brought a giant air-sea force (including more British Catalinas) to hound and harry Bismarck to her death May 27.

The turn of the tide in the Pacific started with victory in the naval Battle of Midway in the summer of 1942. This was a carrier-plane show, but the Cats stole a little of it. Ens. Jack Reid's PBY made the first contact with the Japanese fleet the morning of June 3, sighting the supply train on a patrol nearly 700 miles west of Midway. Next morning Lt. W. L. Richards led four PBY-5As in a courageous torpedo attack on these fleet elements, and Ens. Gaylord D. Probst, reported missing after the action, scored a hit on the oiler Akebono Maru.

The main enemy striking force was discovered June 4 by Lts. Howard Ady and William Chase, co-pilots of a PBY-5 search plane. They sent repeated messages giving distance and bearing, then managed to elude planes launched against them by four Japanese carriers.

After the Battle of Midway had been won, Comdr. Massie Hughes sent PBYs out on daily flights to search for missing aviators. From bobbing liferafts they rescued a total of 27 -- including the aforementioned Ens. Gaylord D. Probst.

In the desolate Aleutians, target of a simultaneous attack, some 20 PBYs of Patrol Wing 4 (Capt. Leslie E. Gehres) comprised the Navy's air arm, sharing the defense burden with a meager force of Army planes. Catalinas first sighted the enemy force June 2, and on June 10 discovered the enemy beachhead on Attu. Beginning June 11 they resolutely tried to carry out an order from Pearl Harbor to bomb the Japanese out of Kiska, staging round-the-clock sorties from the tender Gillis for 48 exhausting hours.

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* Morison, History of U. S. Naval Operations in World War II, Vol. III, P. 205. The editors have relied heavily on the first 10 volumes of Prof. Morison's work in piecing together the Catalina story.

Nowhere was Catalina duty tougher. A Navy historian has thus described the life of Patwing 4:

> Blow high blow low, thick weather or clear, they had to fly. This meant warming up the engines with blowtorches, scraping snow and melting ice off the wings, loading heavy bombs or torpedoes with numbed hands, taking off in the dark, sometimes down-wind with an overloaded plane, and, if the plane were water-based, with frozen spray obscuring the windshield.....
>
> Any plane forced down in the wild open sea was doomed, and unless rescued promptly the survivors died of exposure. On the flight home there was always the danger of being dashed to bits against a mountain while the plane "hung on the props" over the field, waiting for a hole in the overcast. Once safe ashore, the crew had to help overhaul their Catalina. In the early days of the campaign the PBY ground crews lived a sort of gypsy existence, begging tools, clothes, food and even shelter from the Army or any naval vessel that happened along.*

When our landings on Guadalcanal signaled the opening of the long Pacific amphibious campaign in August 1942, Rear Adm. John S. McCain's SoPac Cats were in the thick of it. Tender McFarland took station at Ndemi in the Santa Cruz Islands Aug. 5 as a base for five PBYs, and on Aug. 7 (D-day at Guadalcanal) tender Mackinac moved to Malaita so her nine flying boats could cover search sectors northward toward the enemy citadel at Truk. By October, Task Force 63 (land and water-based planes under Rear Adm. Aubrey W. Fitch) included 32 PBYs and the tenders Mackinac and Curtiss.

The Black Cats -- The PBY had two great virtues, cruising range and rugged dependability. But neither it nor the later and larger flying boats of World War II, notably the Martin PBM and Convair PB2Y-3, had the speed or armament for combat duelling. Late in 1942 the PBY's usefulness was extended by adapting some planes for scouting and bombing under cover of night. This was a specialized mission in which the Catalinas served well during the island-hopping campaigns of the Pacific.

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* Morison, Vol. VII, Pp. 15-16.

In December, operations were started from Guadalcanal by Squadron VP-12 (organized under Lt. Comdr. J. P. Fitsimmons, subsequently skippered by Comdr. Clarence O. Taff). Equipped with radar and painted jet black, planes of the squadron (the "Black Cats") normally took off after 10 p.m. to range up "the Slot" all night on search and bombing missions, or to spot gunfire for surface bombardments.

In every ocean theater the Catalina became celebrated as a rescue craft. An early and typical example was reported from the Caribbean in March 1942, when a PBY flown by Ens. F. E. Pinter spotted a loaded liferaft between San Juan and Guantanamo. Landing in a rough sea, Pinter and his crew hauled aboard 17 men and 1 woman, haggard survivors of the torpedoed merchantman Barbara. Pinter barely got off by "giving her the gas on the bounces." It required 20 minutes' flying to climb to 500 feet.

By early 1943 specialized rescue Catalinas were operating in the Pacific to pluck stranded aviators from hostile waters and shores, often within range of enemy gunfire. Nick-named "Dumbo" (after Walt Disney's flying elephant), the South Pacific rescue planes were credited with bringing back more than 160 flight crewmen in the first 18 months. By war's end the total rescued in all theaters would run into many hundreds.

In the Southwest Pacific, Catalinas of Patwing 10 that survived the early withdrawals from the Philippines and Netherlands East Indies were based at Perth, Australia and became the nucleus of the Seventh Fleet air arm. Expansion of land and tender-based air activities in 1943 brought commissioning of Patwing 17 (Capt. Thomas S. Combs) at Brisbane. By the following summer it was Fleet Air Wing 17 (Commodore Combs), with three squadrons of Catalinas, two of Liberators, and one of PV-1 Venturas, plus six seaplane tenders -- Currituck, Heron, Orca, San Carlos, Tangier and Wright.

As the New Guinea campaign opened forward bases, elements of Fairwing 17 moved northwestward, until by late summer of 1944 tender Wright was stationed at Owi Island near Biak, whence her Catalinas could range as far as Philippine waters or the Celebes on patrol, anti-shipping and Dumbo missions.

When Liberators of the Fifth and Thirteenth Air Forces raided Borneo oil refineries from New Guinea that fall, the rescue Cats performed brilliantly. The 307th Bombardment Group lost four B-24s in the Balikpapan strike of Sept. 30, but PBYs picked up the complete crews of three and a half of the men from the fourth. Maj. Gen. George C. Kenney, commander, Allied Air Forces, has reported that 50 P-38 fighter pilots volunteered to accompany B-24s to Balikpapan, knowing they would run out of gas on the return flight, "if I would just send six or seven rescue Catalinas out to meet them." The pilots were confident they could "simply parachute down and get picked up by the Cats."*

Combs was relieved as commander of Seventh Fleet Aircraft in July 1944 by the officer who had commanded Patrol Wing 10 in the retreat from the Philippines -- now Rear Adm.. Frank D. Wagner. When the Philippines were recaptured that winter, it seemed fitting that he should return to Manila Bay flying his flag on the seaplane tender Currituck, mother ship to many a Catalina.

Anti-Submarine Cats -- While the Pacific PBYs performed their innumerable missions in the long campaign from Guadalcanal to Okinawa, Catalinas in the Atlantic were chiefly occupied with anti-submarine warfare. This began with the organization of the Neutrality Patrol, continued through the period of "measures short of war," and reached a climax in the 1942-43 offensives against the U-boat.

Five 12-plane squadrons -- VP-33 and VPs 51-54 -- were assigned to the patrol when it was organized in September 1939. After Roosevelt negotiated the bases-for-destroyers deal with Great Britain, three Cats from Patrol 54 were moved to Bermuda, and early in 1941 Patron 52 was sent to the new U. S. base at Argentia, Nfld. On Aug. 6 the Cats of Patwing 6 (Capt. H. M. Mullinix) moved to an American base at Reykjavick, Iceland.

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* Kenney, General Kenney Reports, P. 438.

The Navy had seven PBY patrol wings in the Atlantic at the time of Pearl Harbor, but these were reduced to bolster Pacific operations. In January 1942, when Adn. Doenitz unleashed a massive submarine offensive in American waters, there were four PBY outfits remaining, at Argentia, Norfolk, Jacksonville-Key West and San Juan-Trinidad.

Spread thin in two oceans, the Navy scored only eight U-boat kills the first six months of 1942. The first in which a PBY participated took place July 12-13 when a Cat from Patwing 3 (Panama Sea Frontier) caught and depth-charged the U-153 off Almirante. Air-sea units held the damaged boat submerged until destroyer Lansdowne polished it off next day. The pace quickened in August. On the 20th a PBY-5A skippered by Lt. (jg) R. B. Hopgood sank the U-464 south of Iceland, and on the 28th a Cat from VP-92, operating out of Guantanamo, blew theU-94 to the surface for a kill by ships.

A South American patrol was established in the opening days of the war. Six PBY-5s of Patron 52 arrived Dec. 11 at Natal, Brazil, eventually the headquarters of Fleet Air Wing 6. Cats patrolled the entire rim of Brazil; Patrons 83 and 94 were reviewed by President Roosevelt when he stopped at Natal in January 1943, returning from the Casablanca Conference.

The PBYs saw plenty of action after the Nazis opened a U-boat blitz off Brazil in the summer of 1943. By then the subs had adopted the tactic of staying on the surface and duelling planes. Lt. (jg) Frank F. Hare, piloting a Patron 94 Catalina, was killed in such a fight with U-590, but a sister Cat flown by Lt. (jg) S. E. Auslander found the sub two hours later and sank it with bombs.

On July 21 Auslander had an indecisive hour-long battle with U-662 while escorting an 18-ship convoy. The next day the submarine was sunk by a Cat piloted by Lt. (jg) R. H. Howland.

On July 24, three planes attacked the U-199, and the kill was credited to a PBY of the Brazilian Navy.

On the far side of the Atlantic, Patron 63 joined the great Allied anti-submarine offensive in the Bay of Biscay in July 1943. Equipped with MAD (magnetic airborne detector), this outfit bore the nickname "Madcats." On Aug. 1 one of its PBYs, the "Aunt Minnie," was attacked over the bay by eight or more German Ju-88s. Minnie bagged one fighter before she was shot down. The three survivors included Lt. William P. Tanner, the Catalina pilot who had sighted the Japanese midget submarine at Pearl Harbor.

The Madcats' detectors proved ineffective over the broad reaches of Biscay, but helped seal the Straits of Gibraltar against U-boats after VP-63 was shifted to the Moroccan Sea Frontier. There the Cats of Fleet Air Wing 15 (Capt. T. A. Tanner) operated from Port Lyautey and Agadir.

Liberators -- B-24 and PB4Y

The four-engine Liberator bomber was most famed for its great range, which enabled it to make the longest strikes staged by heavies* on either side of the world -- the 2,350-mile Balikpapan raids in the Southwest Pacific in 1943, and the missions from North Africa against the Romanian petroleum center of Ploesti in 1942 and 1943.

In the months before Pearl Harbor, range and carrying power also made the B-24 attractive as a transport for the new Air Corps Ferrying Command (later the Air Transport Command), and it was in this capacity that the Liberator saw its first military duty. On July 1, 1941 Lt. Col. Caleb V. Haynes opened the AAF overseas route to England with a B-24, taking off from Washington to fly to Scotland via Montreal and Newfoundland. On Aug. 31, Haynes and Maj. Curtis E. LeMay pioneered the South Atlantic route in a B-24, carrying Maj. Gen. George H. Brett to Cairo on a special mission. (Brett was so impressed by the bomber's range, he suggested to the British that they divert B-24 deliveries from England to the Middle East.)

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*The B-17s and B-24s were "Heavies;" the B-29 and B-32 "very heavies."

In September, two B-24s carried part of the Harriman Mission to Russia, flying 3,150 miles nonstop on the Scotland-Moscow leg of the trip. Returning, these planes surveyed routes that would later bear heavy military traffic. Maj. Alva L. Harvey routed his flight via the Middle East, India, Australia and Hawaii. Lt. Louis T. Reichers flew from Moscow to Cairo, and thence across central Africa to Brazil.

The British put their early Liberators (which they called LB-30s) to work as transatlantic transports for ferry pilots, or as long-range anti-submarine planes. One was modified as a personal transport for Prime Minister Churchill, and named "Commando;" it carried him to the Casablanca and Cairo conferences.

In order to obtain sneak photos of the Japanese bases at Truk and Jaluit, Gen. Arnold had two B-24s specially modified and armed in 1941 for a flight from Hawaii to the Philippines. These were the first Liberators assigned to the Pacific, and one of them became the first U. S. B-24 casualty of the war. It arrived in Hawaii Dec. 5, and was blown to bits on the ground in the Japanese attacks of Dec. 7.

The AAF's "Project X" followed, for rushing bombers to the relief of the Philippines. The first step was to repossess 15 British LB-30s that were still in this country. None reached the Philippines, but four traveled via Africa and India in time to join the 7th Bombardment Group on Java in January. On the 16th, three of these LB-30s and two B-17s under command of Maj. Austin A. Straubel took off from Singosari airfield, Malang, to strike Japanese shipping in Manado Bay and bomb the Langoan airfield. This appears to have been the first U. S. Liberator bombing mission of the war. Another "first" grew out of the same mission, when Lt. John E. Dougherty's bomber crash-landed on an islet off South Borneo. Eight days later the crew was rescued by a Navy Catalina -- a feat to be repeated scores of times for Liberator crews in the years ahead.

Three Ferry Command B-24s also were early arrivals in the Southwest Pacific. Diverted from the Ferrying Command's Washington-Cairo run, they shuttled between Australia, the Philippines, the Netherlands East Indies and Burma, carrying high-ranking military personnel, urgent cargo and evacuees. By March 1942, all three had been lost.*

The B-17 Flying Fortress, first delivered to the Air Corps in 1937, was on hand in small numbers throughout the Pacific area when war started, and bore the major share of combat the first year. The AAF decided in 1942 to make the Pacific an all-Liberator ocean, however. Within another year, the B-24 (and its Navy counterpart, the PB4Y-1) were the only U. S. heavies flying over a segment of the globe stretching from Alaska to India. (See Table, next page.)

The first all-B-24 outfit to reach a Southwest Pacific combat zone was the 90th Bombardment Group (Col. Art Meehan), trained in Hawaii. It began arriving in Australia Oct. 23, 1942 to join the recently created Fifth Air Force (Gen. Kenney).

Its first mission was an 8-plane strike Nov. 16 at shipping in the Buin-Fasi anchorage, Bougainville. Kenney decided soon afterward to withdraw the 90th for additional training, however, and its 60 planes did not begin intensive missions until January 1943. By spring its squadrons were battering targets as distant as Makassar and Kendari in the Celebes. Another Liberator group, the 380th, was based at Darwin and ranged as far west as Java on 14-hour missions.

The 13th Air Force (Brig. Gen. Nathan F. Twining) was activated in the South Pacific in January 1943, with headquarters at Espiritu Santo. It began receiving B-24s in February with arrival of first units of the 307th Bombardment Group. (The battle-worn 11th Group, a B-17 outfit that had been in the South Pacific since mid-1942, returned to Hawaii to become a B-24 unit of the 7th Air Force).

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*This summary of early Liberator duty, and much of the matter that follows, is derived from the six volumes so far published of Craven and Cate, The Army Air Forces in World War II.

TABLE xxxx

HEAVY BOMBERS ON HAND, BY A.A.F. THEATERS, 1942-45 *
(Figures for last day of month)

	European		Mediterranean		Pacific Ocean Areas		Far East		C.I.B.		Alaska		Latin America		TOTALS	
	B-17	B-24	B-17	B-24	B-17	B-24	B-17	B-24	B-17	B-24	B-17	B-24	B-17	B-24	B-17	B-24
June 1942	--	--	--	17	73	--	67	--	19	5	8	9	23	--	190	31
Dec. "	179	41	149	68	1	40	110	60	10	22	11	21	20	18	480	270
June 1943	783	51	269	192	1	42	70	170	4	94	5	25	17	18	1,149	592
Dec. "	1,302	308	289	268	--	105	--	363	--	167	--	16	9	25	1,600	1,152
June 1944	1,471	1,458	315	982	--	240	--	474	--	112	--	21	5	41	1,791	3,328
Dec. "	2,168	1,183	509	951	--	222	--	403	--	115	--	17	--	69	2,677	2,960
June 1945	1,147	159	457	91	--	236	--	526	--	173	--	15	--	70	1,604	1,270

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* Compiled from Army Air Forces Statistical Digest, World War II (AAF, 1945), Pp. 157-82. Note that figures do not include bombers in continental USA or in transit, more than 2,000 B-24s transferred to Allied governments, or 977 in Navy service as PB4Y-1s.

As amphibious forces "climbed the island ladder" from Guadalcanal northward, Twining's Liberators conducted far-ranging strikes against enemy bases and shipping. By October 1943, when missions in support of the Bougainville invasion were nearing a climax, most of the 13th's B-24s were based on Guadalcanal -- the 307th Group at Koli Field, the 5th Group at Carney.

A unit of 10 specially equipped Liberators (carrying new radar sighting devices) joined the 5th in August and was assigned to the 394th Squadron. Designated SB-24s, the planes flew low-level missions up the Slot almost nightly, attacking Japanese convoys in the waters around Bougainville, and were credited with sinking more shipping after dark than regular Liberators did by day. The SB-24s later were organized as a separate squadron, the 868th. Owing to virtual disappearance of night shipping targets in the spring of 1944, these aircraft turned to pathfinder service with the high-altitude heavies.

The 7th Air Force was created at Hawaii in February 1942 (Maj. Gen. Clarence L. Tinker; after his loss in the Battle of Midway, Maj. Gen. Willis Hale). A crossroads outfit until the fall of 1943, it rarely had more than one group of its own.

The 7th mounted its first B-24 strike Dec. 22, 1942, when 26 B-24Ds of the 307th Group flew 1,194 miles (with a staging stop at Midway) to hammer Wake Island with 500-pounders and incendiaries. This was the first blow at any Japanese-held base in the Central Pacific and caught the Nips by surprise; only two planes were damaged. Wake was hit again in January, May and July 1943, the last raids being made by the 11th Group.

In April 1943 the 7th used its long-legged Liberators for another distant strike, a punch at Tarawa and Nauru in the Gilbert Islands, more than 2,000 miles from Hawaii. Hale himself led the flight of the 371st and 372nd Bombardment Squadrons. They reached the staging field at Funafuti April 18. Two days later Hale took 22 Liberators more than 1,000 miles to plaster the Nauru airfield and phosphate works in the face of heavy interception. Five planes were badly damaged, and a Japanese counter-raid on Funafuti put six more out of service next morning. After 12 B-24s hit Tarawa April 22, Hale returned his bombers to Hawaii overnight 00 a flight that he laughingly called "the longest and fastest retreat in military history."

The 7th's B-24s and a squadron of Navy PB4Y-1s were flying off excellent new U. S. fields in the Gilberts that winter, in support of the forthcoming invasion of the Marshalls. When the 7th Division went ashore at Kwajalein Feb. 1, 1944, B-24s of the 392nd Squadron furnished "ground support," dropping 1,000- and 2,000-pound bombs from only 4,000 feet, then strafing the defenses with .50-caliber machinegun fire.

The Pacific campaign developed as a two-pronged offensive, Gen. MacArthur moving from Australia through New Guinea into the Philippines, while forces under Adm. Nimitz swept north and west from the Solomons to seize the Gilberts, Marshalls, Marianas and Ryukyus. Two Japanese strongholds lying between the lines of advance, Rabaul and Truk, were neutralized with repeated air attacks, then by-passed without occupation. Here the Liberators played a major role.

The reduction of Rabaul was accomplished in the fall and winter of 1943. The first large strike by the 5th Air Force was staged Oct. 12. Seven squadrons of B-24s (43rd and 90th Groups) struck from Port Moresby, New Guinea, along with waves of P-38 fighters and B-25 medium bombers. The base was hammered incessantly for the next four months in the face of savage interception and fierce antiaircraft fire. Liberator gunners had their hands full; witness this incident in the strike of Oct. 25:

> One plane in the last squadron, the 403rd, was badly damaged and promptly set upon by Japanese fighters. Two bombers, dropping back to box it in for protection, shot down eight enemy planes before they had to pull off. Then, for fifteen minutes the Japanese lined up to make their passes, but the plane still flew. Not until after the enemy had given up did the two remaining engines cut out and the plane break up after ditching. The pilot and co-pilot were trapped, but eight of the crew got out and were picked up by a Catalina. *

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* Craven, IV, p. 324.

The 13th AF relieved the 5th in November, so that Kenney's lads could concentrate on softening up Gasmata and Cape Gloucester. Flying principally from Munda, on New Georgia, Liberators of the 5th and 307th groups continued pounding Rabaul through the early months of 1944, but by mid-February it was substantially eliminated as an enemy air center.

Truk became the No. 1 target of 5th and 13th AF heavies from March to September 1944. The first strike was staged from the Gilberts March 14-15 by the 30th Bombardment Group (Col. Edwin B. Miller). The 38th Squadron flew up from Makin and the 392nd from Apamama, staging at Kwajalein, where each plane took on six 500-pound bombs and 3,150 gallons of gasoline. Arriving over Truk at night after a 1,096-mile flight, the Liberators met little resistance (the first wave found all lights turned on), and scored heavily on hangars, a seaplane base and a tank farm. For the 392nd Squadron, whose home field was the farthest removed, this one mission required a total flight of 4,255 miles.

The raid was the first land-based attack on Truk and brought the 30th a series of commendations. A few weeks later another B-24 outfit won a Presidential Unit Citation for bringing off the first daytime strike against Truk. The assault was conducted March 29 by the 307th Group (Squadrons 370 and 424), flying from Munda with staging stops at Torokina and Nissan. The bomb pattern "walked across the target" despite heavy antiaircraft fire. Afterward the Liberators fought off an estimated 75 fighters in a 45-minute running battle. Two bombers were lost; casualties totaled 10 dead, 10 missing and 11 wounded.

While the attacks on Truk continued, 7th AF Liberators teamed with Navy PB4Y-1 photo planes April 18 for the first land-based raid on Saipan, in preparation for the invasion June 15. After Saipan and Guam were secured, the 7th moved forward to the Marianas but kept an eye on Truk until mid-1945, periodically dropping bombs on its battered airfields and seadromes.

The Balikpapan Raids -- During the New Guinea campaign, a cherished goal of Kenney's was acquisition of an airfield within Liberator range of the refineries at Balikpapan, Borneo, which he believed to be the primary source of Japanese aviation fuel. Borneo was within extreme cruising distance for Australian-based B-24s; nine heavies of the 380th Group reached Balikpapan on an amazing 17-hour round trip flight from Darwin in August 1944, but were able to hit the target only lightly.

With capture and improvement of the Noemfoor airfield in northwest New Guinea that fall, it was believed Balikpapan had been brought within extended B-24 range if the mission were carefully planned: 2,350 miles round trip, to be covered in a little over 14 hours' flying time, starting with a load of 2,500 pounds of bombs and 3,590 gallons (21,540 pounds) of fuel. *

Representatives of Convair and Pratt & Whitney (engines) worked with 5th and 13th AF/ officers in setting up the flight plan, including a timetable for shifting weights: Transfer bomb bay (auxiliary) fuel at 4 hours, shift one crewman from waist to tail at 6-1/2 hours, bring two crewmen forward to flight deck at 9 hours. Ninety minutes after leaving the target, all machinegun ammunition (1,362 pounds if none had been fired) was to be jettisoned.

Seventy-two heavies of the 5th, 90th and 307th groups took off from Noemfoor starting at 4 a.m. Sept. 30 and all but two reached the target, the Pandansari refinery being hardest hit. Heavy AA and fighter interception cost four Liberators. The 307th Group was badly battered in the next strike Oct. 3, when the 20 planes it put over Balikpapan were intercepted by 40 fighters from a crack naval air unit. During a running engagement that lasted 70 minutes -- all the way back to the coast of Celebes -- 24 fighters were shot down, but the group lost seven bombers.

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* On a typical routine mission, 5th AF Liberators flew about 1,500 miles in 9 hours, carrying 6,000 to 8,000 pounds of bombs and 2,000 to 2,700 gallons of fuel. Missions were calculated for a ground speed of 157 mph, cruise altitude of 8,000-9,000 feet, bombing altitude of 12,000-13,000 feet.

The fourth and most successful raid put 73 Liberators over the refineries Oct. 14, accompanied by long-range P-38s and P-47s from the new fighter base at Sansapor, New Guinea. After this assault the Edeleanu refinery was in ruins and the Pandansari out of action, though repairable. *

The cost of the Balikpapan strikes was high -- 22 bombers and 9 fighters -- but 60 combat crewmen were rescued by Catalinas and the submarine USS Mingo; and 152 Japanese fighters were claimed shot down. (Maj. Richard I. Bong, the leading AAF ace, supposedly was retired from combat at this time, but he accompanied one mission as an "observer" and got his 29th and 30th kills.)

The Philippines were coming up next. From northwestern New Guinea, 57 B-24s took off Sept. 1, 1944 to drop more than 100 tons of bombs on Davao airdromes, the first daytime heavy bomber strike against a Philippine target since early 1942. With the invasion of Leyte in October, the 5th and 7th groups lent support from a forward base on Morotai, and by mid-November two squadrons of 494th Group B-24s were operating from a new Liberator base on Angaur, in the Palaus. The 22nd Group arrived at Angaur a little later, and on Dec. 22 sent 23 Liberators to strike Clark Field, Manila, with a staging stop at Tacloban. Thereafter the 22nd and 494th took turns battering airdromes in the Manila area, until enemy air operations were hopelessly disrupted.

While 5th and 13th AF heavies supported the Philippines campaign, pounded Formosa and joined in the successful air-sea effort to cut Japan's southern lifeline, the 7th AF was hammering the Bonins -- the 30th Group from Saipan and the 11th from Guam. Between November and January the Liberators flew 1,836 sorties against Iwo Jima, and stepped up this attack prior to D-day (Feb. 19) with round-the-clock bomb and napalm raids. By D-minus-4 the B-24s had

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* After the war, interrogation of Japanese showed that the most effective neutralization of Balikpapan probably was achieved by mine-sowing Catalinas of the Royal Australian Air Force. Their nighttime sorties crippled shipborne oil deliveries.

dumped 5,582 tons of bombs on Iwo, and a naval bombardment expended more than 9,000 tons of shells the final three days. (Neither attack, as it turned out, did much damage to elaborate underground defenses.)

With invasion of the Ryukyus in April 1945, airfields could be built putting the heavies within range of the Japanese home islands. In July the 11th Group moved to Okinawa from the Marianas, and the 494th from the Palaus. Elements of the 22nd, 90th and 380th groups also arrived at Okinawa during July, and the 43rd began operations from Ie Shima. The 373rd Squadron, a B-24 snooper outfit, was transferred from China and attached to the 494th. Fifth and 7th AF bombers now began hitting airfields and railroad marshalling yards on Kyushu, and in the Shanghai and Hangchow areas of China. Only a week before the atom bomb fell, B-24s bombed Nagasaki rail terminals July 31 and Aug. 1. One of the last Liberator missions was a successful fire raid Aug. 11 on Kurume, incendiaries dropped by 53 planes burning out 28 per cent of that city.

Alaska, China, India -- In Alaska, the 11th Air Force (Brig. Gen. William O. Butler) entered the war with the 36th Squadron, made up of B-17s and one LB-30. Some B-24s were added in time for the mid-June strikes at Kiska from Cold Bay. The 404th Squadron arrived in July 1942, basing at Nome to conduct a Bering Sea patrol. Originally destined for Africa, the 404th's Liberators wore desert camouflage and picked up a local nickname, the Pink Elephants.

After we occupied Adak and completed a landing field in September, a dozen B-24s of the 21st and 404th squadrons teamed with fighters Sept. 14 in a new and successful tactic, low-level bombing of Kiska. The attack damaged shipping and started numerous fires, but could not be repeated at once; for 10 days in a row the U. S. airfields were completely socked in. (Weather took a heavier toll than the Japanese. Between June 3 and Oct. 31 the 11th AF lost 79 planes of all types, only 9 of them destroyed in combat).

After the Japanese were tossed out of the Aleutians in the summer of 1943, Liberator duty consisted principally of periodic raids and photo reconnaissance flights over the Kuril Islands.

The 10th Air Force (Maj. Gen. Lewis H. Brereton) was activated at Patterson Field, Ohio, on Feb. 12, 1942 and assigned to the new China-India-Burma theater. Until creation of the 14th AF in China a year later, it operated with meager resources from India, the only U. S. air unit in an area far larger than the United States, at the end of the longest supply line in existence.

The 10th's first mission was staged with five aircraft April 2. Brereton led a flight of one LB-30 and two B-17s against Japanese shipping in the Andaman Islands, the crews claiming hits on a cruiser and a transport. Two B-17s were assigned targets at Rangoon but were unable to complete the mission. Attacks on enemy forces overrunning Burma continued until June, when Brereton and his bombers were hastily transferred to the Middle East, where the German offensive under Rommel threatened Cairo.

In July the China Air Task Force (Brig. Gen. Claire L. Chennault) was set up for operational command of the 10th's units in China, and the first heavy bomber strike in that country was staged Oct. 21 by B-24s of the new India-based 7th Bombardment Group. The 436th Squadron (Maj. Max R. Funnell) took off from Chengtu to strike the Lin-hsi coal mines, beyond Tientsin.

In India, the 7th Group Consisted of four full Liberator squadrons -- the 436th and 492nd, based at Gaya; and the 9th and 493rd, at Pandaveswar. In November these B-24s began strikes at Mandalay, and demonstrated their long-range hitting power Nov. 28 with a 2,760-mile round trip attack on Bangkok, seriously damaging an oil refinery. On Dec. 30, 20 Liberators nearly destroyed Monywa in central Burma.

The 14th AF (Chennault) was activated in March 1943 with headquarters at Kunming, and a new B-24 outfit, the 308th Group (Col. Eugene H. Beebe) was ready for its first mission May 4.

Eighteen Liberators traversed the Gulf of Tonkin to hit Sama Bay on Hainan Island, facing the China Sea; hits were scored on the airdrome, docks, an oil refinery and a fuel dump. On May 8 the heavies attacked Tien Ho airdrome at Canton, and then retired to ferry in fuel, bombs and supplies from India. The 308th had a unique and onerous distinction among Liberator groups: As a condition of operating in China, it was required to furnish all of its own supplies by shuttling over the Hump.

In June, Japanese forces were pushing up the Yangtze toward Chungking and the alarmed Chinese called for air support. Liberators escorted by Chinese fighters operated from a Chengtu field, plastering enemy troops in the Yangtze gorges until they began to fall back.

The Japanese appeared bent on destroying the heavy bombers. Their fighters often passed up B-25 bomber flights altogether to concentrate on the Liberators. This proved disastrous for the 425th Squadron in a strike at Hankow Aug. 24, made by heavy and medium bombers with an escort of P-38s and P-40s. The squadron's seven planes made an excellent run despite heavy antiaircraft fire, severely damaging an airdrome, but were attacked immediately afterward by a swarm of 40 enemy fighters. After a 45-minute battle only three Liberators remained, all badly crippled, and one of these crashed on the return to Kunming, killing 10 of the 12 men aboard.

In November 1943, the 308th Group's Liberators were transferred temporarily to India to join the 14th AF and RAF in an Allied air offensive against Rangoon, a blow conceived by Maj. Gen. George Stratemeyer, the Southeast Asia air commander. AAF Liberators and Mitchells were to strike by day, RAF Wellingtons and Liberators by night. Bad weather hampered the operation, and savage Japanese interception made the cost high, the 308th suffering six B-24s destroyed and five serious damaged on a single strike. The most successful mission was flown Nov. 27, when Liberators and Mitchells destroyed an estimated 70 per cent of the Insein locomotive works.

During the literation of Burma, October 1944--May 1945, the 7th Group's heavies ranged far to the east and south from India, to mine ports and disrupt communications leading into Burma from Thailand, Indo-China and Malaya. One notable mining operation was conducted in October by B-24s flying a 3,000-mile round trip from Kharagpur, India, to sow the inner approaches to Penang, Malaya. Each of the 15 Liberators laid four 1,000-pound bombs "precisely in the position ordered" without a mishap.

A high-priority target, the Ban Dara bridge in Thailand, was wrecked by Liberators Nov. 3; the next night they made a heavy, successful strike at the Makasan workshops in Bangkok. (By now, devices for increasing the bomb load and conserving fuel made it possible for B-24s to take off from India and carry a load of 8,000 pounds of bombs to Bangkok, 1,000 miles away).

The Azon bomb, controllable by radio in flight, was put into use by the 10th AF in December 1944 and proved invaluable as a bridge-buster. Use of this weapon, requiring special equipment and trained personnel, was given to the 493rd Squadron. Stratemeyer reported in 1945 that "Azon bombing continues to be highly successful, with one mission getting four bridges with four bombs."

In China the Japanese ground forces overran most of the airfields used by the 14th AF in 1944 and early 1945. To assist a Chinese army that continued to fight along the Suichwan-Kukong axis, Chennault in November organized the East China Air Task Force, largely a fighter outfit but having a B-24 detachment from the 308th Group. After collapse of Chinese resistance in that area, the 308th's Liberators took up pounding of the enemy's rail repair depots in north China. In a major strike March 9, 1945 a force of 31 B-24s with 12 escorting Mustangs took off from Hsinching and Kwanghan for a mission against Sinsiang that destroyed 17 warehouses and damaged or destroyed seven locomotives. Similarly successful raids followed against rail yards at Shih-chia-chuang and Tsinan.

B-24s Against Germany -- In the Battle of the Atlantic, the Liberator's endurance made it a favorite of all antisubmarine forces. Until mid-1943 the AAF supplied most of the land-based craft searching from the Americas, and B-24s equipped with microwave radar began coming into service in the fall of 1942. This was about the time the I Bomber Command (Brig. Gen. A. N. Krogstad) was transformed into the AAF Antisubmarine Command (Brig. Gen. Westside T. Larson).

By 1943 the command had 25 squadrons, composed chiefly of B-24s modified for VLR (very long range) service -- capable of cruising outward for 1,000 miles and remaining on station four hours before starting home. Carrying less armor and fewer guns, these Liberators had extra fuel capacity and electronic gear.

The first special Liberator unit to go overseas was the 1st Army Antisubmarine Air Squadron (Lt. Col. Jack Roberts), dispatched to England in November 1942. The 2nd AAAS followed in January, and both took part in the Bay of Biscay anti-U-boat offensive before moving on to Morocco, to search from Port Lyautey as elements of the 480th Group. The 6th and 19th Squadrons were shifted from Newfoundland to England in the summer of 1943, serving as the 479th Group, attached to the RAF Coastal Command; in July they racked up three U-boat kills.

The Navy organized its antisubmarine 10th Fleet in the spring of 1943, and a long Army-Navy jurisdictional squabble was resolved in June with an agreement reached by Gen. H. H. Arnold for the AAF, Rear Adm. John S. McCain for the Navy, and Lt. Gen. Joseph T. McNarney, Army deputy chief of staff. As a result, the Navy assumed responsibility for all air antisubmarine operations and its Liberators (PB4Y-1s) began replacing B-24s. The AAF airmen transferred to the Britain-based 8th Air Force. In some cases, Navy crews took over the former Army planes. Thereafter the Navy patrolled the Atlantic from bases in both hemispheres, and by mid-1944 eight of its PB4Y-1 squadrons (a total of 96 planes) were flying from England under RAF operational command. In the Azores, Fleet Air Wing 9 also flew Liberators under British control.

The 8th Air Force (Maj. Gen. Carl Spaatz) was activated in January 1942 and assigned to England for strategic bombardment of Germany. Its first strike was a 12-plane B-17 raid on Rouen Aug. 17. The B-24s made their debut Oct. 9, when 24 Liberators of the newly operational 93rd Group teamed with 84 B-17s in a blow at the Lille steel and locomotive works. This was the first time the 8th AF had dispatched more than 100 bombers on one day. (By late 1944 the biggest raids would find more than 2,000 heavies airborne at once from the British Isles.)

During the winter and spring of 1942-43, major targets of the Flying Fortresses and Liberators were the U-boat pens and yards at Lorient, Brest, St. Nazaire and Wilhelmshaven. By May, Adm. Doenitz conceded that the towns of St. Nazaire and Lorient had been erased as submarine bases, though repair work continued inside the heavy concrete pens, which proved indestructible.

After June 1943, 8th AF heavies were occupied chiefly with the Combined Bomber Offensive. This was a strategic concept worked out at the Casablanca Conference, calling for U. S. and British bombers to seek "progressive destruction and dislocation of the German military, industrial and economic system." The 8th struck at Kiel, Wilhelmshaven and Antwerp; made its first large-scale attack on the Ruhr, and in July ranged over Norway for the first time. By Sept. 6, when three B-24 groups had returned from temporary duty in North Africa, the 8th was able to launch a flight of 407 bombers against targets in northern Germany.

The potential had grown to more than 3,000 bombers by February 1944, when British-based heavies staged a six-day series of missions that came to be known as "the Big Week."

This offensive opened Feb. 20 when 16 combat wings (more than 1,000 aircraft) were sent against 12 fighter plane production centers in Germany and Poland. The fury of the week's assault reached its peak the 24th when a coordinated mission flung waves of bombers at the Reich from two directions. While the 15th Air Force flew up from Italy to strike targets in southern Germany, the 8th sent 12 wings of heavies against the Schweinfurt ballbearing plants, the Me-110 fighter works at Gotha, and FW-190 plants in northeastern Germany and Poland. The three B-24 wings that struck Gotha were credited with especially accurate bombing; post-war assessment showed loss of six to seven weeks' production by the Me-110 works.

By now the German fighter force had perfected a bag of new tactics -- coordinated attacks by single-engine fighters, air-to-air bombing, and the firing of rocket fusillades at extreme range by twin- engine fighters. The Big Week cost the 8th AF 137 heavy bombers, and the 15th lost 89. (By the summer of 1944, the 8th's losses would mount to more than 300 heavies a month.)

March 4 brought the first U. S. bomber attack on Berlin, when one wing penetrated bad weather to hammer the Klein Machnow suburb. Two days later, 660 aircraft attacked targets in and about the Nazi capital, losing 69 bombers and 11 escorting fighters in a savage air battle. U. S. crews claimed 179 enemy craft shot down, and air opposition was notably weaker in the follow-on raids of March 8 and 22.

From late 1943 until May 1944, the weight of the 8th AF was thrown into Operation Crossbow, the Allied aerial effort to knock out V-bomb launching sites along 300 miles of French coast. Then beginning in May, the heavies delivered thousands of tons of bombs on enemy rail centers and airdromes in preparation for the Normandy invasion. During the first week in June they joined in massive assaults on the coastal defenses of Hitler's Atlantic Wall. On D-day (June 6), the 8th in an intricate pre-dawn assembly operation dispatched 1,361 B-17s and B-24s to plaster the invasion beaches, flying in formations of six squadrons abreast.

In the weeks that followed, missions often were tactical. Another masterpiece of intricate assembly work was accomplished for the St. Lo breakout of July 25, when 1,507 heavies carpet-bombed an area ahead of the jump-off line, dropping 3,300 tons of bombs in 60 minutes.

But the 8th's mission was primarily strategic, and after D-day it concentrated on relentless pummeling of the enemy's synthetic oil industry, transportation network and aircraft plants. By December it could dispatch more than 2,000 heavies in a major effort; on the 24th it sent 1,400 four-engine bombers against 11 airfields east of the Rhine, and 634 more against 14 communication centers. The long-range fighter protection so badly needed in the early stages of the European war was plentiful. When the heaviest daylight assault ever made on Berlin was staged March 18, 1945 by 1,250 four-engine bombers, no less than 14 groups of P-51 fighters flew escort. By now great stretches of Hitler's capital were in ruins, and the Allied armies were closing from two directions.

Lt. Gen. Carl Spaatz, commander of the U. S. Strategic Air Force, proclaimed the end of the strategic air war April 16, in a message to the commanders of the 8th AF (Doolittle) and 15th AF (Twining). By May the 8th's heavies were ferrying liberated prisoners out of Germany, dropping food on the Netherlands, taking thousands of ground crewmen on aerial sightseeing trips over the broken Reich, or starting redeployment to the Pacific.

North Africa -- The 9th Air Force came into existence in the Middle East on Nov. 12, 1942 (Maj. Gen. Lewis H. Brereton, transferred from India). Its nucleus was the Halverson Detachment, a unit of 23 picked B-24D's that had been organized in the States in the spring of 1942 to make a Doolittle-type raid on Tokyo from some base in China. Under command of Col. Harry A. Halverson, the outfit crossed the South Atlantic and Africa, but on reaching Egypt was detained for what was to be a single special mission, a long-range strike at the Romanian oil center of Ploesti.

This mission (not to be confused with the massive B-24 assault on Ploesti of August, 1943) was the first strike made by U. S. heavy bombers against a target within Festung Europa. Thirteen Liberators took off singly from the RAF base at Fayid the night of June 11, and all but one reached Ploesti at dawn next morning. Bomb damage was scant, and some planes were lost through internment when they landed in neutral countries, but the long-range strike was a token of massive assaults to come.

Now Halverson's B-24s were thrown into the desperate effort to stem Rommel's advance on Egypt, initially with raids on Axis shipping in Bengasi and Tobruk harbors. Destined never to reach China, the Liberators and a handful of B-17s Brereton had brought from India were combined in July as the 1st Provisional Group. Reinforcements began arriving from home late in the month, when B-24s of the 98th Group (Col. Hugo P. Rush) landed at Ramat David, Palestine. By early August the group's four squadrons were all in the Holy Land, based at Ramat David and St. Jean d'Acre.

In the months that followed, the Liberators pounded targets afloat and on both shores of the Mediterranean, as Montgomery advanced from the east and Eisenhower from the west to drive the enemy out of North Africa. By spring 1943, most 9th AF Liberators (98th and 376th groups) were operating from a complex of airfields in the Bengasi area of Cyrenaica, and concentrating their strikes on Naples and Messina. B-24s opened the Sicilian pre-invasion air campaign July 2 with a 91-plane mission against airdromes in southern Italy, and later in the month teamed with B-17s of the 12th Air Force in crippling blows against railroad marshalling yards at Naples and Rome.

Ploesti Revisited -- Ninth AF Liberators were withdrawn from the Sicilian campaign at this point to train for one of the war's most remarkable air operations, a low-level attack on a complex of oil refineries in and near Ploesti, 40 miles north of Bucharest. Ploesti supplied an estimated one-fourth to one-third of Germany's liquid fuel. Until after the invasion of Italy, it could be reached by no Anglo-American bomber except the B-24, flying from Africa.

Col. Jacob E. Smart of General Arnold's advisory council evolved the low-level attack, Eisenhower approved it, and Brereton directed the planning and training. To augment the 9th AF's two groups, the 44th and 93rd Liberator groups were transferred temporarily from England, and the 389th Group (B-24s), scheduled to move from the States to the United Kingdom, wa s diverted to North Africa.

All five groups participated in the mid-July strikes at Naples and Rome, then entered a 10-day period of strenuous training near Bengasi. The crews practiced close-formation, minimum-altitude flying; made repeated bombing attacks on a reproduction of the Ploesti targets, laid out on the desert; underwent intensive briefing, and conducted two full-dress mock missions. For "Operation Tidalwave" the B-24s were fitted with low-level bombsights and auxiliary bomb bay fuel cells, increasing gasoline capacity to 3,100 gallons.

Early the morning of Aug. 1, 177 planes winged north over the Mediterranean past Corfu, then turned northeastward across Albania, Yugoslavia and Bulgaria. Sixty-five miles from Ploesti, the planes dropped to 500 feet.

A miscalculation took the leading 376th Group off course to the outskirts of Bucharest, alerting Romanian defenses. Ground fire of almost unbearable intensity met this group and the following 93rd when they reached Ploesti and launched the attack. The 98th and 44th groups arrived next:

> They found the defenses thoroughly alerted. Equally bad, they had to fly through fires and the explosions of delayed action bombs left by the 93rd. The two groups would have been justified in turning back; instead they drove straight against their targets through intense flak, explosions, flames, and dense black smoke which concealed balloon cables and towering chimneys. B-24s went down like tenpins, but the targets were hit hard and accurately. As the two groups left Ploesti, they were jumped by enemy fighters, and on the way home were attacked by every kind of plane from Me-109s to unidentified biplanes.... *

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* Craven, Vol. II, P. 482.

Only the 389th Group, flying an individual mission against targets at nearby Campina, was able to carry through its attack according to advance planning, and with minimum loss. Its objective was completely destroyed. Altogether, the strikes wiped out an estimated 42 per cent of Ploesti's refining capacity, and eliminated 40 per cent of its cracking capacity for several months. The cost was high -- 54 bombers were lost, and of 1,726 men who had left Bengasi that morning, 532 listed as dead, missing, imprisoned or interned. For heroism the Ploesti mission has few equals in the annals of war, and five of the men who took part in it were awarded the Medal of Honor.

In mid-August the same five B-24 groups staged the first strike launched from the Mediterranean against a target inside greater Germany. Flying more than 1,200 miles, 65 Liberators hit the aircraft production center of Wiener Neustadt, damaging assembly plants, hangars and grounded planes. Complete tactical surprise was achieved and only two bombers were lost. It was a different story when the attack was repeated Oct. 1. Heavy flak and 60 German fighters brought down 14 bombers, but the Liberators dumped 187 tons of bombs on assembly shops, storage areas and rail lines.

The 15th Air Force -- After the Allies seized the southern end of the Italian peninsula and knocked Mussolini's government out of the war, the 9th AF was transferred to England in the fall of 1943, to become a tactical outfit in support of the forthcoming Normandy invasion. Strategic bombing from the Mediterranean theater was assigned to a new organization, the 15th Air Force, formally activated Nov. 1. Under command of Maj. Gen. Nathan F. Twining after January, the 15th's heavies were to hammer the Axis from the south while Doolittle's bombers struck from the United Kingdom.

Manduria on the Italian Heel became the initial Liberator base, two groups of the 47th Wing shifting there from Africa late in the year. By mid-January 1944, six additional groups, each composed of 62 B-24Hs, had arrived from the States -- the 449th, 450th, 451st, 454th, 455th and 456th. Additionally, the 15th was allocated 739 B-24s (with 937 crews) and 200 B-17s (178 crews) through February. Monthly allotments of 171 Liberators and 60 Fortresses were scheduled thereafter.

The 15th's first heavy strike was staged Nov. 2 against Me-109 complexes at Wiener-Neustadt, Regensburg and Leipzig; 112 B-24s and B-17s dropped 327 tons of bombs with widespread damage. It was estimated the raid had reduced German single-engine fighter production by 30 per cent for four months. The attacking force claimed 56 enemy fighters destroyed, at a loss of 11 bombers.

It was not only the mass attacks that paid off. On Jan. 19, 1944, the 449th Group sent 27 B-24s to drop 65 tons of bombs on the German long-range reconnaissance airfield at Perugia. This raid totally disabled the field for four days, and was credited in large measure with the complete tactical surprise achieved by the invasion force that hit the beaches at Anzio Jan. 22.

In support of a stalled ground offensive in central Italy, 15th AF heavies hammered enemy transportation during the spring. A high point came March 28 with the first "thousand-ton" raid, participated in by bombers from 13 groups. A series of raids inflicted tremendous damage on rail yards at Turin, Milan, Bologna, Genoa and other cities.

As a prelude to the August invasion of southern France, 15th AF Liberators ranged westward that summer -- pounding Toulon harbor, rail yards at Miramas, Nimes and Avignon, airfields at Chanoines and Valence, and gun emplacements around Genoa, Savona and Marseille. Returning to the Italian campaign, B-24s concentrated the "tactical" end of their work that fall and winter on transportation targets, notably rail lines in the vicinity of Brenner Pass.

From mid-1944 on, the Combined Bomber Offensive gave top priority to German oil, and it is for this strategic campaign that the 15th AF is best remembered. Its prime targets were oft-bombed Ploesti, the crude refineries around Budapest and Vienna, and synthetic petroleum plants at Brüx, Oswiecim, the two Blechhammers and Odertal.

At Ploesti the Germans developed an effective defensive technique -- lighting hundreds of smoke pots on the approach of bombers, thus concealing the area in a blanket of dense smoke. The 15th's answer was massive blind bombing through the smoke. A total of 20 daylight attacks were made in the summer of 1944, together with night missions by RAF Wellingtons. After three large assaults in mid-August, refinery operations were brought to a complete and permanent halt. In knocking Ploesti out of the war, the 15th expended more than 13,000 tons of bombs and suffered the loss of 350 bombers.

Savage attacks on other oil targets followed. Almost 500 B-24s and B-17s were sent against refineries in Poland and Czechoslovakia Aug. 20, with loss of only four aircraft. An even larger mission the 22nd struck such targets as the synthetic plants at Odertal and Blechhammer. On the 24th, the 15th AF teamed with the 8th in one of the largest coordinated attacks of the war, sending 600 heavies against oil targets in Czechoslovakia and western Germany, while 1,300 bombers from England hammered oil and aircraft objectives of their own.

One of the 15th's largest efforts came the first week in November, against targets near Vienna. The Florisdorf refinery was pounded the 5th by 500 planes, dropping 1,100 tons of bombs; next day the bombers were back to dump more than 400 tons on Moosbierbaum. A series of sustained operations during December halted oil production at Odertal, Oswiecim, Brux and Blechhammer. By the end of the year only four crude oil refineries and a half dozen synthetic plants were operating in all of Germany.

The 15th's last great strike against oil came March 15,1945 when 522 Liberators and 225 Fortresses plastered Florisdorf with 1,667 tons of explosives. Now the war was almost over for the heavies. On March 21, a force of 366 Liberators carried out a classic strike against Neuburg, substantially obliterating its jet plant and airfield in a single blow. Four days later Twining's heavies bombed tank plants and airfields at Prague, in what proved to be the 15th's final strategic strike of World War II.

TABLE xxx

DISPOSITION OF 16,278 ARMY AIR FORCE B-24s *

Transferred During War	
To foreign governments	2,111
To U. S. Navy	847
Used Overseas	
Missing, missing in action, lost in combat	1,907
Condemned	1,716
Salvaged	1,946
Damaged beyond repair	855
Used in Domestic Operations	
Missing, crashed, damaged beyond repair	865
Used in ground training (USAF Class 26)	104
Transferred to Disposal Agencies	
To R.F.C., various areas	5,815
To Defense Plants Corp.	38
To War Assets Administration	11
In Use, 1951	
In active service with USAF	1

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* From an inventory prepared by USAF for U. S. Court of Claims, covering disposition of 16,278 B-24s procured between April 1943 and the end of the war; minor items omitted. Some 2,000 B-24s ordered earlier were not included in the litigation, Davis Airfoils vs. U. S. Government.

CHAPTER X

RECONVERSION AND COMEBACK, 1945-50

As it had after World War I, the aviation industry shrank by a process resembling collapse starting in mid-1945. Convair quickly closed out its satellite divisions at Tucson, New Orleans, Allentown, Louisville and Elisabeth City, and San Diego Plant II was turned back to the government. By March 1946, the corporation-wide payroll had dwindled to 12, 822. President Harry Woodhead noted in his annual report: "Until the nation's policy concerning airpower is firmly established, the aircraft industry will remain in a somewhat unsettled state."

The little Stinson Division converted quickly to production of four-place Voyager 105s for the civilian market and enjoyed apparent health. But the three main divisions were occupied largely with incubation of the military and commercial products that were to bring Convair preeminence in selected fields later -- the Convair-Liner at San Diego, the B-36 intercontinental bomber at Fort Worth, and at Vultee Field the forerunners of the delta wing F-102, the Terrier missile and the awesome Atlas ICBM.

Convair management was deeply involved in the problems of reconversion: To hold a trained technical force together and keep working capital profitably employed. One Vultee Field project was the development of a prototype plastic-and-aluminum packaged home. Experimental flying autos were given a whirl at San Diego. In January 1946, a controlling interest was purchased in ACF-Brill Motors Co. of Philadelphia (transit buses) and its wholly owned subsidiary, Hall-Scott Motor Car Co. of Berkley, Calif. (auto and marine engines). At an outlay of two and one-half million dollars, the Nashville plant was equipped to manufacture kitchen ranges and freezer cabinets for Crosley Corp. (an Avco affiliate) and buses for ACF-Brill.

Meantime, the late summer of 1946 saw the opening of quiet negotiations that would have ended Convair's existence by merging it into Lockheed Aircraft. The proposal was that Lockheed absorb the aviation divisions; that Avco withdraw, taking the Nashville property and ACF-Brill; and that Convair stockholders receive one shart of Lockheed for each 1-1/6 shares of CVAC. These terms were agreed to by Victor Emanuel, chairman of Consolidated since Girdler's resignation in April 1945. But the merger movement lost momentum and plans to put it to a stockholders' vote were dropped. A major factor was the setback suffered by Lockheed's principal commercial asset, the Constellation airliner. It was grounded by the CAA in July and did not get back into service for several months.

From 110 to 440 -- At San Diego the immediate post-war effort centered in developing a medium-range twin-engine transport, the 40-passenger Convair-Liner. Planners projected it as "successor to the DC-3" (the remarkable transport Douglas introduced to commercial airlines in 1936 and produced during the war as the C-47.) Once in service, the Convair-Liner quickly won worldwide approval for comfort, economy and dependability; by 1956 it was the standard medium-range transport of nearly 40 domestic and foreign airlines. But the birth period was one of severe travail, consuming the company's resources and drawing it deep into debt.

It was realized from the outset that the program would lose money for a time, but Laddon advocated going through with it for several reasons: To keep the work force together, develop a commercial market, and offset the indifferent requtation of the C-87. (This was a frankly makeshift transport, developed for the Air Force during the 1942 transportation crisis, by modifying B-24 bombers.) At this time Convair had an excess profits "carry forward" of some 25 million dollars; at worst, the company could lose this amount on the liners and suffer a net loss of only 5 million. The program went ahead; directors believed deliveries would start by mid-1947, and that the first 158 would pay off engineering and tooling costs.

Throughout 1946 and 1947, however, the Convair-Liner was beset by rising costs and unforeseen delays. Engineering and tooling charges climbed to $13,200,000. Other manufacturers were having the same trouble. After surveying the industry in 1947, the Congressional Aviation Policy Board concluded: "The cost of design and prototype development . . . is so high that neither the manufacturers nor the air carriers can today afford to invest the sums involved."

Early orders for 120 planes were placed by two lines, American and Western, but the commercial sales staff found going tough thereafter -- many carriers wanted new equipment but few could finance it. Competition with the rival Martin 202 had adverse effects: Convair underpriced its merchandise (less than $200,000 a piece on one order) and succumbed to "versionitis," the major modification of a basic design to please a customer. (One wanted the self-contained stairway forward, another aft; a third wanted it omitted.)

Using wartime factory production curves, the company had conculded that liners could be built with fewer than 30,000 man-hours of direct labor. Redesign to meet unforeseen CAA requirements, material shortages, a 101-day strike in 1946 and other factors revised the estimate to 55,000 hours by 1947; the final cost was 68,000 hours per plane on the original production run of 168 liners. (Later of course this was brought into line. In 1955 the enlarged Model 340 was being built with 32,200 direct man-hours.)

The prototype Model 110 (first flown in July 1946) and the production Model 240 (March 1947) incorporated many refinements. The cylyndrical fuselage was pressurized, permitting the liner to fly comfortably at economical altitudes. A self-contained hydraulic stairway let the plane load and discharge passengers without assistance from a ground crew. The cabin heating system was engineered to eliminate a common airliner nuisance, drafts. Professional airline pilots were consulted on arrangement of the cockpit.

Once design and production difficulties were ironed out, the Convair-Liner program began to roll. Deliveries totaled 94 in 1948. By 1956, the tenth anniversary of Model 110, more than 1,000 of the planes had been produced in commercial and military versions. Convair estimated the liners had flown 13 billion passenger miles, claimed for them "the best safety record of any commercial aircraft." On the 44-passenger 440 Metropolitan, brought out in 1955, the direct operating cost was only 1.79 cents a seat mile on a typical 165-mile flight.

Out of the Red -- Operating losses during development of the liner led to changed managing ownership and a refinancing program in 1947-48. Convair's net income the last war year, 1945, had been 6.7 million dollars on sales totaling 644 millions. In 1946 sales amounted to only 13.7 millions and the net income column showed a deficit of 2.7 millions. The lowest ebb was reached in 1947, when millions were being spent on the Convair-Liner, a steel shortage hampered operations at Nashville, and the B-36 program was still in early production stage at Fort Worth. The end of the year showed losses of 36 millions, with 32.3 charged to the liner program. After tax recoveries the loss was still 16.7 millions.

This was a "special situation" that appealed to Floyd B. Odlum, president of the Atlas Corp., a veteran investment company. He defined a special situation as one in which the potential assets of a company seemed to outweigh its immediate liabilities. Atlas acquired 117,200 shares of CVAC stock (about 7 per cent of the total) in the open market during the summer of 1947. Negotiations followed between executives of Atlas and Avco (26 per cent), leading to a proposed three-way transaction:

1. Avco would withdraw from CVAC, surrendering its stock and paying an additional sum in cash to acquire effective ownership of the Nashville property and ACF-Brill.*

2. This would leave Atlas the controlling strockholder (10 per cent after retirement of Avco's shares). Nine directors nominated by Atlas would replace nine Avco men on the CVAC board.

3. Consolidated would net an estimated 5 millions in cash to apply against outstanding bank loans of 15 millions.

A contract signed in October was ratified at a CVAC stockholders' meeting Nov. 6, 1947, and the board was reorganized at a meeting Nov. 20, with Odlum replacing Babcock as chairman. A year-end audit showed the company's position was worse than anticipated -- losses and inventory write-downs had reduced working capital below the capital/loans ratio required by the banks. An issue of 1, 159, 849 additional shares of common was sold to existing stockholders in 1948, increasing capital funds by 10.3 million dollars, and a new commercial loan arrangement was made with a group of banks. Dividends, dropped to 50 cents in 1947, were omitted entirely in 1948 and 1949.

LaMotte T. Cohu, president of Trans World Airlines and former general manager of Northrop Aircraft Corp., was named Convair president June 4, 1948. Laddon, a director since 1931 and executive vice president since 1942, resigned but continued to serve on the board.

The Vultee Field Division at Downey had been shut down in July 1947, and its experimental plane, missile and rocket projects transferred to San Diego. The Downey property was leased to North American Aviation, Inc., early in 1948, and further retrenchment followed that summer with shutdown of the Stinson Division. Stinson turned out nearly 5,000 Voyagers and Flying Station Wagons after the war, producing 44 per cent of all four-place private craft sold in 1947. The Michigan plant then succumbed to quick saturation of the civilian plane market. (Nationally, production fell from 34,874 units in 1946 to 15,616 in 1947.) A backlog of unsold planes accumulated in the spring of 1948, the plant was closed June 30, and on Dec. 1 Convair sold the Stinson tools, designs, name and good will to Piper Aircraft Corp.*

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*Additional details will be found in the appendix, Page

At the end of 1948, Convair continued operating in the red (loss was reduced to 11.9 million) but the turning point was at hand; in 1949 the company earned a profit of 3.7 million dollars, the first in four years.

It would be gratifying to record that Convair's engineering brains and managerial skills had straightened out the Convair-Liner program (which they had), and thus restored the company to economic health. Such was not the case, for the truth is that no major aircraft company in modern times has remained self-supporting unless a major percentage of its production was in government (military) aircraft.

Thus the upturn was foreshadowed in 1948, when Convair's annual sales grew from 47.4 millions to 112 (principal orders being placed by the Air Force, 82 millions; the Navy, 5.3, and the airlines, 20). Profitable operation returned in 1949 when airline sales grew to 24 millions, and military sales to 173 millions. For this, Convair's development of the biggest bomber ever built was largely responsible.

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*In July 1955, Piper sold its stock of Stinson parts and the Stinson name to Vest Aircraft Co., Denver, Colo. The old Stinson property at Wayne was retained by Convair until 1950, when it was transferred to a subsidiary, Airfleets, Inc., which sold it the same year to General Motors for $850,000.

Intercontinental -- The XB-36 had first flown at Fort Worth on the morning of Aug. 8, 1946. Hundreds of cars stood bumper-to-bumper along White Settlement Road and Grant's Lane, streets bordering the field at Carswell Air Force Base, by 9:30 o'clock. Then the takeoff was delayed a half hour so thousands of Convair employees could leave plant buildings west of the field and mass along the fence. Test Pilot B. A. Erickson revved up the palne's six pusher engines and released the brakes. The cigar-shaped giant accelerated down the runway on wheels nearly 10 feet high and lifted smoothly, borne on a broad swept wing having double the span of the four-engined B-24. The crowd roared.

Over the next eight years, 384 more B-36s would roll down the same runway to give the Air Force a powerful fleet of intercontinental bombers (capable of flying 10, 000 miles without refueling and dropping a 10, 000-pound bomb load at the half-way point). The B-36 was to serve as the nation's prime nuclear weapon carrier in a decade of cold war. (Gen. Nathan F. Twining, Air Force chief of staff, would say in 1955 that the B-36 "perhaps more than any other factor has kept us from being attacked.")

Although first flown in 1946, the B-36 dated back to a time nine months before Pearl Harbor. On April 11, 1941 the Air Corps invited Consolidated and Boeing to submit preliminary design studies for a bomber of intercontinental range. (At this time the longest-range bombers of World War II, the B-29 and B-32, were still in the mockup stage.)

On May 3, Consolidated submitted a preliminary proposal for a high-wing twin-tail, pressurized monoplane resembling the final B-36. Design studies continued during the summer. Germany's swift invation of Russia increased fears that the Axis powers might conquer all Europe, leaving the United States isolated. When the problem was reviewed at a high-level Air Force conference Aug. 14, four companies were reported to be at work on intercontinental bomber designs -- the two named plus Douglas and Northrop (the last on a flying wing that became the XB-35).

On Aug. 24 the Chief of the Air Corps was directed to supply the most up-to-date information on desired characteristics to all four. In October, after reviewing data submitted by the various companies, the Air Corps decided to award a contract to Consolidated for two experimental six-engine bombers. A cost-plus-fixed-fee contract was signed Nov. 15, and construction of a mockup started at San Diego.* By 1942, however, the coast plant was employing all its capacity for bomber and seaplane production and the XB-36 project was transferred in August to the new Fort Worth plant.

The original delivery dates had been May and November, 1944, but these were not met for many reasons. Early design was slowed by revision of the Air Force's armament requirements, a shift from twin to single tail configuration, and problems of weight and balance control. Higher priorities given aircraft already in production deferred wind tunnel tests, and delay was encountered in development of the new Pratt & Whitney R-4360 Wasp Major engine, a 28-cylinder giant that weighed 1-3/4 tons and developed a hitherto unheard of 3,000 horsepower. The most persistent problem, however, was assignment of low manpower and material priorities to the XB-36 program until late in the war.

Thus a contract for 100 B-36s was awarded Aug. 7, 1943, but construction of the Experimental Building in which the ptorotype was to be built did not start until September. Fabrication gained speed in 1944, and in October the Air Force approved construction of the 8,200-foot runway the bomber would need. Before hostilities ended, Air Force studies had picked the B-36 as the plane aronnd which the post-war air arm should be built.

Sheer size was the bomber's most distinctive feature; one pilot likened the experience to "sitting in the bay window and flying an apartment house." From a design standpoint, however, the greatest novelty was the use of pusher propellers, seldom employed since the earliest days of aviation. The reasons for this configuration were two (one trivial), and the consequences were three (one bad).

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*The sequence of events leading to award of the XB-36 contract is taken from The Army Air Force in World War II, Vol. VI, P. 244.

When the original design was laid out in 1941, an NACA "laminar flow" wing section was adopted. This was a comparatively recent airfoil, developed to maintain a perfectly smooth air flow across wing surfaces. Since propellers and engine nacelles create local turbulence, it was decided to locate them aft in the B-36. A secondary consideration, engineers conceded in later years, was the appeal of a planform that was "different."

The first benefit of the design was discovered when the XB-36 started flight-testing in 1946. The plane proved to have better climbing capabilities at high altitudes than designers had predicted. This would be of great importance over the next ten years. "High" meant 35,000 feet with the B-36 was born; in the race for upper-atmosphere supremacy she would have to learn to fly above 50,000 feet.

The second benefit of having power plants aft was this: If an engine caught fire, flames streamed out behind the plane instead of burning like a blowtorch against the wing. In practice it was found that an engine could blaze away until it burned free and fell from a B-36 yet the bomber could still come home.

On the debit side, the propellers created a vexing vibration problem. At the top and bottom of their 19-foot arc the tips passed through clean, high-speed air, but in the plane of the wing's trailing edge the blades crossed through a zone of slow, turbulent slipstream. This set up strong vibrations throughout the trailing edge area. Engineers who entered the wing aloft to study the phenomenon under flight conditions found that vibration numbed their feet within seconds.

The problem this created was one of metal fatigue -- the cracking of light aluminum and magnesium parts subject to vibrational flexing. Since the vibration had to be accepted, fatigue was combatted with many small design changes. One type of fabrication that proved especially resistant employed Convair's patented Metlbond process, in which a rubber-base adhesive is applied between surfaces and set under pressure and heat. In such secondary structures as stiffening panels, this "spreads the stress" instead of concentrating it along rivet attachment lines.

Production models started coming off the line in August 1947, delivered without armament as familiarization trainers. The first service delivery was made the following June to the Seventh Bomb Wing at Carswell. On Dec. 7-8 a Carswell B-36 established its range with a simulated mission to Hawaii, flying 9,600 miles nonstop and dropping a 10,000-pound load en route home.

At this stage of its development the B-36 was not yet entirely secure. The Boeing B-50 (aB-29 souped up with R-4360 engines) was faster, though lacking in range. The jet medium bombers were coming along. For a time Gen. George C. Kenney, chief of SAC, belonged to the dissenting Air Staff minority. (He felt that the B-36 might have a better future in aerial tanker or anti-submarine service; later he became the bomber's strong advocate.)

The plane's performance was steadily improved, however, and history took a hand in the summer of 1948. Top Air Force officers met with Air Secy. Stuart Symington June 15 to begin a final evaluation of the bomber program. While these sessions were under way, Russia clamped a tight blockade on West Berlin, creating a crisis so grave that two U.S. bomber groups were placed on the alert. The Symington conference ended June 25 with a unanimous decision to go ahead with the intercontinental B-36.

Through fiscal 1948 the B-36 had been financed with wartime funds. For fiscal 1949 Congress voted appropriations predicated on rebuilding the Air Force to 70 groups. (At the time there were 59. Plans called for procurement of 5,309 planes over the next three years.) Events that followed drew the B-36 into the center of an inter-service controversy.

To carry out an Administration economy program, President Truman and Defense Secy. Louis A Johnson put the Air Force under a 48-group ceiling in the fall on 1948 and imposed similar curbs on Army and Navy planning. The 70-group program collapsed. Within the next few months contracts totaling more than 300 million dollars were terminated (including those for the Northrop B-49 "flying-wing," the North American B-45 medium bomber and the Boeing B-50). Concurrently the B-36 schedule was stepped up on recommendation of Lt. Gen. Curtis E. LeMay, new commander of SAC. In January 1949 a senior board decided to order 39 more B-36s for 172 million dollars, and in March approved an additional order for 36. Convair as a result was receiving an expanding share of a shrinking defense dollar.

While these events were taking place a rebellion was simmering among top Navy officers who feared that two clubs -- economy and the Unification Act -- were being used to reduce the naval air arm to nullity. These convictions were strengthened in the spring of 1949 when Johnson (who happened to be a former Convair director) abruptly canceled construction of the super-carrier USS United States. Soon the House Armed Services Committee began an investigation of rumors that the B-36 contracts had been awarded through favoritism or collusion, and that the bomber itself was worthless, an easy prey to Navy jet fighters.

A parade of government and industry witnesses cleared up the first charge to everyone's satisfaction. Cedric Worth, a Navy civilian aide whose "black paper" had set off the investigation, publicly recanted. Chairman Carl A. Vinson announced in August that the committee had found no evidence whatever of fraud, collusion, influence or favoritism.

The merits of the B-36 itself continued to be debated when the hearings were reopened that fall, to investigate defense policies and unification problems. The best remembered critical phrase is Adm. Arthur W. Radford's; he described the bomber as vulnerable and ineffective, "a billion dollar blunder." (In retrospect, a Radford quotation that came closer to the heart of the Navy's position was this: "The B-36 has become...a symbol of a theory of warfare, the atomic blitz....Many reject this theory.") In rebuttal the Air Force marshaled its top voices -- Arnold, Kenney, Vandenberg, LeMay -- and Army Gen. Omar Bradley, chairman of the Joint Chiefs of Staff, sided with them. The hearings adjourned without an immediate verdict. (Formal findings the following March stressed the committee's belief that each service knew best what weapons it needed to discharge its mission, whether bombers or ships. Special indignation was voiced over cancellation of the super-carrier.)

Prevailing opinion when the hearings ended appears to have been summed up by Hanson W Baldwin, New York Times military writer. He observed that the B-36 lacked the speed of such new planes as the jet B-47, "but range, its great asset, cannot be shrugged off." He concluded that "as an aerial force-in-being...the B-36 justifies its existence; as long as any potential enemy has an atomic bomb such a force must exist."*

Faster and Higher -- The Air Force continued building its potential for "massive retaliation" until it had a fleet of more than 350 B-36s. The last was delivered from Convair-Fort Worth on Aug. 14, 1954. By then only the basic airframe resembled the prototype. Since 1946 the bomber had added more than 100,000 pounds in gross weight, more than 100 mph in speed and more than 10,000 feet in service ceiling.

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*New York Times, Nov. 13, 1949, P. 34.

The B-36B of 1948 introduced the first major power improvement, a new R-4360 engine with water injection. This added 500 hp to the rating of each unit. On January 29, 1949, a B-36 set what probably will remain an all-time record for bomb lift by taking a pair of dummy 42,000-pound Grand Slam bombs aloft at Muroc (now Edwards AFB) in California; the first was dropped from 35,000 feet, the second from 40,000.

During the 1949 hearings, testing was under way on the 10-engine B-36D. Four auxiliary jets were paired in pods slung beneath the outer wing panels. This boosted top speed to "over 435 mph" and the prototype climbed to 47,700 feet; service ceiling was now rated officially at "over 45,000." In 1950 the new B-36F introduced the dash-53 line of R-4360 engines, rated at 3,800 hp each.

Over the years there was a continuous program of modification in the bomber's instrumentation, armament system and fuel tankage; by the time final model B-36J flew in 1953 the gross takeoff weight had grown to more than 400,000 pounds (contrasted with 278,000 in the original XB-36). Modernization programs brought the earlier models up to standard, and there were two important modifications -- the RB-36 strategic reconnaissance version, and the "Ficon" GRB's, equipped to carry a jet fighter to a distant launching point and retrieve it in the air afterward. (Details of models and modification will be found in the technical section, Pp. .)

Unique among all B-36 variants was the NB-36H, flying test bed for an airborne nuclear reactor. This modification was built and flown at Fort Worth after the Air Force awarded Convair a contract in 1951 for development of the first atomic-powered airframe. (Development of the power plant was assigned to General Electric.) The NB-36H flew on conventional power, carrying the small Convair-built test reactor far aft in the fuselage.

At the time of the 1949 Congressional hearings the Air Force predicted a useful life of at least five years for the B-36. Toward the end of this period (beginning in 1953) a research program was launched to lighten and streamline the bomber, that it might push its service ceiling above 50,000 feet, the optimum altitude of contemporary jet fighters. By an unofficial but authorized account, * Operation Featherweight succeeded in reducing the plane's gross weight some 100,000 pounds. One of the solutions was to jettison all defensive armament except the radar-controlled tail cannon.

"Since the B-36 can fly level above 50,000 feet, it is virtually immune to attack from above," the authors of the account reported. "In the thin air 10 miles up, the B-36 with its giant wingspread can actually out-maneuver the stubby-winged, heavily loaded fighter." Electronic countermeasures were said to constitute the bomber's defense against guided missiles.

During Symington Subcommittee hearings on air power in 1956, Gen. Twining confirmed that special stripped B-36s were flying above 50,000 feet "and can go higher than the Bear" (the Russian intercontinental bomber.) At that time the B-36 was scheduled for phase-out as jet Boeing B-52s replaced it. Of SAC's 11 heavy wings, however, 10 were still B-36 outfits stationed in the U.S., North Africa and Guam.

Thus, 15 years after design started, the last and greatest of the piston-engined bombers -- "designed in the maturity of one air age, flying in the infancy of another" -- was still strongly in business.

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*Anderson and Blumenthal, "Our Air Force's 'Sunday Punch'," Parade Magazine, March 11, 1956, Pp. 12-14. The article was prepared with Air Force cooperation and submitted for review before publication.

CHAPTER XI

DELTAS AND TERRIER -- 1945-56

The Convair division at Vultee Field has "worked itself out of a job" by mid-1944. Manufacture of basic trainers for the Air Force and Navy stopped when the Downey assembly line had produced more than 11,000. A reduced factory force turned to making components for planes in production at other plants. The engineering staff tackled a broad array of research and development projects in new fields -- supersonic flight, rocket propulsion, missile guidance. From pioneering work at Vultee Field in 1945-46 came the world's first delta-wing aircraft (XF-92A, F-102), the West's first supersonic bomber (B-58), the Navy's first operational antiaircraft missile (Terrier), and developments leading to what is expected to be the first intercontinental ballistic missile (Atlas).

A research project already under way bridged the shift from propeller-driven planes to craft powered with reaction motors. The XP-81, conceived in 1943 and flown in 1945, used both turboprop and independent jet. An all-jet design followed in 1944-45, a proposed Navy night fighter powered with three turbojet engines and having the high subsonic speed of 561 mph.

Early in April 1945 this entry appeared in the weekly Engineering Department reports: "Work has just started on possible airplanes for supersonic speed....A turbo rocket power plant seems to be the most promising at the present time. Practically no aerodynamic data are available in this speed range, and what there is isn't consistent." (It will be recalled that this was 2-1/2 years before man's first supersonic flight, in the Bell X-1 rocket plane at Muroc, Oct. 14, 1947.)

The Air Force announced a competition in September 1945 for a supersonic interceptor, capable of climbing to 50,000 feet in four minutes and attaining a speed of 700 mph. At Downey the design problem was turned over to Frank W. Davis, assistant chief engineer, Adolph Burstein, chief of design, and Ralph H. Shick, chief of aerodynamics. Their studies produced a proposal that won a contract in May 1946 for two XF-92 planes. The design incorporated a swept wing, V tail, and ducted rocket (ramjet) power plant, with external liquid rocket motors for takeoff and climb, and an auxiliary turbojet for subsonic cruising.

It soon became evident that two problems would have to be separated and solved independently -- design of the unique power plant, and development of a supersonic airframe. In November 1946 the XP-92 contract was amended to provide two programs. One led to extensive laboratory and wind tunnel experimentation with ramjet burners and gasoline-oxygen rockets. A design configuration incorporating these elements reached mockup form in 1948. (Additional details will be found under XP-92, Pages .) The other program was confined to aerodynamics and led to the delta-winged interceptors of the Fifties.

Birth of the Delta -- The original XP-92 configuration used a wing swept back at 35 degrees. Two so-called "desk models" were built and shipped to Wright Field when entries in the design competition were judged in May 1946. Afterward, one was mounted in Vultee Field's 4-foot wind tunnel to obtain rough preliminary data. The results were immediately disappointing. "Tuft tests indicate that tip stall starts at a 5-degree angle of attack," an early report showed. Lateral control difficulties were found, too. Engineers suspected an entirely new planform would be needed to meet performance requirements. On July 5 this historic notation appeared in the reports: "A 60-degree delta wing will be investigated this week."

The triangular-wing concept was not new. Pre-war studies by NACA had showed the theoretical high-speed advantages of various wing shapes having extremely low aspect ratios.

Power plants for such speeds did not exist. During the war a brilliant German designer, Dr. Alexander Lippisch (father of the Me-163 rocket interceptor), experimented with the delta planform. He built an unsuccessful delta glider (later brought to the U.S. and tested by the Air Force), and conceived the Jager P-13A. This design combined triangular wing with ramjet power for a theoretical top speed of 1, 500 mph. The plane was not built but the designs fell into Russian hands. (If used, they showed what other post-war research has demonstrated, that the Lippisch wing was much too thick to have supersonic capabilities.

At Downey, Burstein was first to advocate giving the delta wing a try. Fillets shaped to fill internal angles behind the swept wings created a delta of sorts; tunnel performance was recorded July 12 as "the best to date." Learning that Lippisch was at Wright-Patterson Air Force Base, Shick arranged a conference at Dayton in late July. He returned convinced that the Convair design group was on the right track. Intensive investigation followed on alternate planforms, with leading edge sweepbacks ranging from 45 to 70 degrees. (Eventually, more than 5, 000 hours of wind tunnel time was devoted to testing the delta.)

One of the outstanding advantages of the triangular wing appeared to be relatively low drag in the transonic region. Airfoils show a shart drag rise starting about Mach .9 and reaching a peak just above Mach 1, then tapering off as the "drag hump" is left behind. Vultee Field studies prepared for the Air Force in November indicated a peak drag coefficient of only .048 for a 60-degree delta, compared with .072 for a 45-degree swept wing of equal area.

These and later studies also proved the delta to be exceptionally stable in thin air, and to have good low-speed handling qualities (due in part to the absence of a distinct stall point.) Additionally, it was realized that the triangular shape was inherently strong, permitting the structure to be at once thin and rigid; and that the delta's area (larger than that of a comparable straight or swept wing) implied greater internal volume for fuel storage.

Model 7002 -- The only indicated disadvantage was poor lift/drag ratio at low speeds, and the Air Force in November 1946 approved construction of a full-scale, 60-degree delta-winged research craft with standard jet power plant, for evaluating the configuration. To conserve research funds, the contract specified completion "in the shortest possible time using available materials. No attempt shall be made to meet existing Army specifications" and "existing parts from other airplanes shall be used where possible." (Convair engineers managed to work into the design the main landing gear from a JF-1, nose gear from a P-63, pilot's ejection seat from a YP-81, and other hand-me-downs.)

The model was designated 7002 (which happened to be the accounting department's work order number). After flight tests and acceptance, the Air Force called it XF-92A to distinguish it from the -92 ramjet project. The design evolved as a midwing monoplane with the engine air intake in the nose. The wing extended almost the length of the fuselage, requiring a radical change from conventional tail configurations. A triangle-shaped vertical fin was mounted, with rudder in the trailing edge.. Functions of ailerons and elevators were combined in "elevons" set into the wing trailing edges.

Construction was well along when Vultee Field was closed in the summer of 1947, and the plane was completed less engine that fall at San Diego. In December it was shipped by Navy cargo vessel to San Francisco and trucked to the NACA Ames Aeronautical Laboratory, Moffett Field, for full-scale wind tunnel tests. These verified previous small-scale tests and the 7002 was returned to San Diego (thumbing a ride on the aircraft carrier Boxer.)

In the post-war decade jet engine improvements seldom materialized as soon as airframe designers hoped. In 1946 it was anticipated that the G.E. I-40 or Pratt & Whitney Nene would offer thrust ratings of 7,000 to 8,000 pounds when 7002 was ready to fly. Instead she was fitted with an Allison J33-A21 (nominal thrust 4,600 pounds) and taken to Muroc, April 1, 1948. The engine lacked power and tests were limited to taxi runs on the 7-mile-long dry lake bed. Then an improved dash-A23 was substituted and the plane flew September 18 with test pilot E. D. (Sam) Shannon at the controls. (He reported normal performance, except for lag in hydraulic-system response to stick and rudder signals.)

Up to now, the delta torch had been carried by a handful of engineers. The radical configuration evoked little enthusiasm within either the company or the Air Force. As the test program proceeded the plane attracted widening attention. Original plans called for retiring it after 50 hours' company testing. Instead, the Air Force took over with a 30-hour evaluation program of its own, and NACA became interested. After a dash-A29 engine was fitted in May 1951 (5,300 pounds thrust plus afterburner), the Air Force and NACA continued testing the heavily-instrumented plane another year.

Test pilots Capt. Charles Yeager and Maj. Frank K. (Pete) Everest did most of the early flying for the Air Force. They found the high-performance plane easy to maneuver and land, and exceptionally stable in the transonic region around Mach .9. The aircraft lacked power to pass Mach 1 and is known to have flown faster than sound only once -- when Yeager flipped it on its back and pulled 4 G's to put it into a vertical power dive. Yet Convair engineers were satisfied they had found a supersonic configuration. In 1951 the opportunity came to prove it.

The "1954 Interceptor" -- Hasty post-war demobilization left the country almost undefended from air attack; there were only a few obsolescent coastal radar installations, one squadron of P-47 day fighters, and one of P-61 night fighters. Events abroad beginning in late 1947 (especially the appearance of the Russian TU-4 bomber) showed the need for a defense able to meet intercontinental attack by high-performance aircraft. An interim system was organized around the F-89C and F-94B all-weather interceptors and the "Lash-Up" radar network. To develop a better defense by the target year 1954, the aircraft and electronic industries were asked to participate in a conference at Air Force headquarters in May 1949.

Here a new approach generated by Gens. Muir S. Fairchild and Gordon P. Saville was introduced. Instead of issuing rigid specifications defining the equipment wanted, the Air Force stated its problem and asked industry to submit ideas leading to an integrated "weapon system." It was agreed development of the electronics for a new interceptor would take longest and should start first. A competition led to selection of a Hughes Aircraft Co. design in May 1950. The airframe competition followed at once. In June 1951, Convair, Lockheed and Republic were chosen to proceed with preliminary development. In September the Convair delta design was picked for the job and designated F-102.

The system originally was to consist of an airframe powered with the projected Wright J67 engine (expected to pack a thrust of some 15,000 pounds); the Hughes MA-1 fire-control equipment, so sophisticated it could take over most pilot functions; the Hughes Falcon (GAR-1) homing missile, and a secondary battery of folding-fin rockets. It soon was seen that not all the advanced features could be developed in time, and a lesser interim program was substituted. This included the F-102A plane, powered with the smaller Pratt & Whitney J-57 engine, and the Hughes MG-3 system, a partial development of the MA-1. The MG-3 could locate the target at long range, direct the pilot on the correct lead-collision course, and at the proper moment prepare and fire missiles or rockets automatically.

Outwardly, the F-102A looked like a big brother of the XF-92A, except for a slim nose and lateral air intakes flanking the cockpit. It was far different structurally -- a strong skeleton of milled aluminum spars and longerons, covered with sculptured aluminum skins. The plane was designed to carry its full load internally: fuel in the wing spaces, more than three-quarters of a ton of electronic gear in the fuselage, and the Falcon missiles in concealed ventral bays. Rockets were fitted into channels contained in fast-acting missile bay doors.

Engineering on a preliminary order for 10 YF-102s began in April 1952, and the first plane was completed Oct. 15, 1953, making its maiden flight October 24 at Edwards Air Force Base. Engineers already were redesigning the fuselage, however. It had been discovered with dismay, earlier in the year, that the YF-102 would not be able to push past the sound barrier; this was demonstrated by a test program with wind tunnel and rocket-powered models. In hopes of saving the plane, Convair and Air Force engineers decided to apply the "area rule," a principle discovered in 1952 by Richard T. Whitcomb, NACA aerodynamicist.*

Whitcomb's studies indicated that in slender, short-winged aircraft, the drag rise near Mach 1 depends primarily on the distribution of cross-sectional areas as measured along the plan'e axis from noes to tail. Where the rate of change in area is rapid, stronger shock waves (and increased drag) result. Whitcomb found he could greatly reduce transonic drag by indenting the plane's body where the wings were largest; this prevented rapid change in the total cross-sectional area.

The third YF-102 on the line was modified according to these principles; its waist was pinched along the wing and its nose was slimmed and legthened. Additionally, the plane was lightened by whittling away some of its excess structure (no longer needed, due to substitution of the light J-57 engine for the J-67 originally planned.) The modified plane, redesignated YF-102A, had a shakedown flight December 20, 1954, and the following day easily exceeded Mach 1 in level flight. These changes, plus a new cockpit canopy and the addition of fillets (raised fairings) on either side of the afterburner housing, comprised the only major differences between the first YF-102 and the production F-102A's.

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*Whitcomb, "A Study of Zero-Lift Drag Rise Characteristics of Wing-Body Combinations Near the Speed of Sound," NACA Research Memorandum L52H108; reprinted in full in Aviation Week, Sept. 19, 1955, Pp. 28 ff.

A new Air Force procurement policy was tried for the first time in the F-102 program. This was the Cook-Craigie plan, named for Lt. Gens. Orval R. Cook and Laurence C. Craigie. Instead of starting full-scale production as soon as a new model is accepted, the contractor delivers a trickle of units for 18 months while the Air Force conducts exhaustive flight tests. Any major changes or improvements are incorporated into permanent factory tooling, so that combat-ready planes are delivered when mass production starts.

Convair moved an F-102 task force into empty Plant II in January 1953, and began delivering occasional production aircraft in April 1954, but did not throw the switch for full-scale output until late in 1955. The first delivery to an operational Air Defense Command unit took place May 1, 1956, when Lt. Col. Charles E. Rigney, commander of the 327th Fighter-Interceptor Squadron, climbed into an F-102A at Convair's Palmdale flight test center and flew it home to George Air Force Base, Victorville, Calif.

By the spring of 1956 the Air Force had awarded Convair four production contracts for F-102A's, three of the orders including TF-102A's, a two-place training version. On May 30 the initial contract was announced for building F-102B's, an improved version of undisclosed character.

Pogo, Dart, Hustler -- Three other delta-winged planes, each the first of its kind, were developed by Convair. These were the XF2Y-1 Sea Dart, an experimental water-based jet fighter; the XFY-1 Pogo, first airplane in the world to take off and land vertically; and the B-58 Hustler, a supersonic medium bomber.

A product of Convair's Hydrodynamic Research Laboratory at San Diego, the twin-jet Sea Dart flew first on April 9, 1953. Its wing, triangular fin and sharp-nosed cockpit canopy gave it a family resemblance to the F-102. The XF2Y-1's most novel feature -- and the one most difficult to perfect -- was a retractable hydro-ski for takeoff and landing. A double ski was used first, but this created vibration and stability problems in the flight period between takeoff and retraction. Designers switched to a broad, single ski for continuation of the tests.

Through 1956, no performance figures had been released on the four planes built to that time. However, it was announced in 1954 that the second model passed Mach 1 on August 3, while executing a shallow dive at 34,000 feet. Thus Sea Dart became the first water-based aircraft to achieve supersonic flight. (The engineering test pilot was C. E. Richbourg. He was injured fatally three months later, when his plane went partially out of control and broke up in flight during a low-level run over San Diego bay.)

A second experimental Navy plane was the XFY-1 Pogo, winner of a 1951 design competition for a convoy escort fighter, capable of taking off from (and returning to) the after desk of an ordinary cargo ship. The Convair configuration employed a short, fat fuselage; stubby delta wings, and a pair of long vertical fins, one mounted above the fuselage and one below. On the ground the plane sat nose-up, resting on four caster-like wheels at the tips of the wings and fins.

At takeoff the Pogo ascended vertically until well clear of the field, then nosed over into conventional attitude to attain speeds of more than 500 mph. To land, the pilot pointed the nose skyward and settled back to the ground by "hanging on the props." A special power plant was developed for the Pogo, combining an Allison YT40-A-14 turboprop engine with a pair of 16-foot coaxial, contra-rotating, turboelectric propellers made by Curtiss-Wright.

Since no man had flown such a craft, engineers evolved a "tethered flight" program, starting with a test stand that held a power plant and part of an XFY-1 fuselage. Under the pilot's control, this simulator could rise five feet.

Next, an elaborate mechanism for limited flight was built under the 184-foot roof of a Navy hangar at Moffett Field, Calif. Cables rose from the nose of the plane to a powered drum at the top of the hangar, running thence to a counterweight at one side. A system of cables and thension regulators was attached to the tail, letting the aircraft rise freely but limiting its lateral travel.

J. F. (Skeets) Coleman, engineering test pilot, made scores of short vertical flights in the hangar during the summer of 1954, feeling out the plane's controls and characteristics. On August 1 he made the first untethered flight outdoors, rising to 20 feet; over the next two days he worked up to 150 feet. "It's more maneuverable and responds faster than any plane I've ever flown," Coleman reported. "We'll do a little more maneuvering, try a few tricks, as we go along."

Pogo was returned to San Diego and based at Brown Field Naval Auxiliary Air Station while Coleman continued testing, until he had taken the aircraft to several hundred feet, nosed it over to 30 degrees, and traveled the length of the runway. He made the transition to full horizontal attitude the morning of November 4, cruising for 20 minutes before returning to land on a 50-foot square. For this, the first successful VTO flight in history, Coleman was awarded the Harmon Trophy.

The latest in the Convair delta family was the B-58 Hustler, designed as America's (if not the world's) first supersonic bomber. It was rolled out of the factory at Convair-Fort Worth in October 1956, started taxi runs October 29, and was taken aloft on its first flight November 11. B. A. Erickson, veteran chief test pilot, was at the controls. It was 10 years since he had taken the XB-36 on its maiden flight from the same runway; once again cars stood bumper-to-bumper along White Settlement Road and Grant's Lane.

The Hustler had the F-102's triangular wing and pointed nose, but the tall, narrow tail was swept sharply back. The slender fuselage was pinched at the waist. Four G.E. turbojet engines were housed in separate nacelles, slung well ahead of wing leading edges. The plane taxied on tall, almost stilt-like tricycle landing gear.

The Air Force released no information on the construction or design performance of the B-58, which stemmed from a 1951 competition for a supersonic bomber to operate at altitudes above 50,000 feet. The plane was ordered into initial production in mid-1954. Under a new weapon system management concept, Convair-Fort Worth was given full responsibility for procuring and installing all equipment except the government-furnished engines. This included 16 complex and virtually automatic subsystems. August C. Esenwein, manager of the Fort Worth Division, reported that nearly 3,000 subcontractors and other suppliers were brought into the B-58 program.

Project Bumblebee -- Next to delta-winged aircraft, Convair's most important military production by the mid-Fifties was missiles. This line also derived from early post-war research at Vultee Field. The impetus came from Project Bumblebee, a Navy program to find an answer to Japanese Kamikaze (suicide plane) tactics. Studies made in 1944 pointed to an ideal antiaircraft weapon not yet created, a ramjet powered, beam-following missile capable of ranging 40,000 yards at supersonic speeds. The Bureau of Ordnance early in 1945 enlisted the help of the Applied Physics Laboratory of Johns Hopkins University.

In an early application of what now is called the "weapons system concept," BuOrd assigned overall technical direction to APL (which had made its mark in development of the proximity fuse). APL selected associate contractors in many fields: pure research, electronics, explosives and the like. Convair was picked to carry the principal airframe responsibility, and had a collateral role in the ramjet burner development.

Vultee Field worked on two types of airframes, a controlled test vehicle (CTV) of subconic speed, for testing stabilization and controls tied to a Bendix beam follower; and a supersonic vehicle (STV) for exploring the aerodynamics of faster-than-sound flight. Both were to be powered with rocket engines supplied by Reaction Motors, Inc.

The CTV (called Gnat) progressed swiftly. The Engineering Department began releasing orders to the shop the first week in June 1945, and the initial unit was shipped to APL June 29. It was fired successfully (meaning that it remained airborne over its expected trajectory) on July 2. The Gnat's velocity was 800 ft./sec. and its endurance 13 secs. By June 1946 the Gnat was following a radar beam (slow); testing was discontinued before all of approximately 90 CTV's had been expended.

The STV-1 (called Snoot) came along more slowly. Information was scant for calculating supersonic loads and drag. Dr. A. G. Mitchell of APL participated in conferences at Downey in July 1945 where C. R. Irvine, Vultee Field chief engineer, and his staff roughed out the configuration "on the back on an envelope." Analysis of aerodynamic data was completed in August and the first missile was sent to APL in October. It was fired at Island Beach, N.J., with results that were typical of the art in 1945: "The missile tumbled immediately after launching and hit the ground 200 yards from the lauching site...The exact cause has not been determined."

After minor modifications the second missile was fired with what might be termed 100 per cent improvement -- it traveled some 400 yards before touching earth. Missile No. 3 was launched with moderate success in January 1946 at the new Naval Ordnance Test Station near Inyokern, Calif., and by March a "fully successful" firing heartened engineers. The slow, painstaking development continued into the summer of 1948 -- through some 90 STV-1s; through the STV-2 series (first fired in August 1947), and the early STV-3s (f/f April 8, 1948).

Then something happened that wasn't supposed to. The contracting team had solved the aerodynamic and control problems so well that BuOrd and APL decided to convert STV-3 into a tactical weapon, without waiting for perfection of the ramjet motor originally desired. Thus Terrier I was born.

Terrier, Tartar, Lark -- Design of the prototype Terrier was finished early in 1949 at Convair-San Diego, where the Vultee Field projects had been transferred in 1947. Additional refinements were cranked into a series of five small production lots over the next four years, while an extensive program of flight testing was carried out -- on simulated shipboard equipment at NOTS -- Inyokern starting in 1950; aboard the laboratory ship USS Norton Sound in the Pacific after September 1951; and by the Operational Development Force in the Atlantic, 1952-53.

Terrier came of age Aug. 12, 1953, when the test ship USS Mississippi launched a full-configuration missile, equipped only with smoke-puff warhead, and knocked down a high-flying F6F drone. This end had been foreseen and the Navy was far along with preparations to make the missile operational. First naval personnel had been assigned to training in the Convair engineering department in 1950. A formal course in theory and operations was started at San Diego in 1951; early graduates were organized into Guided Missile Unit 21 (assitned to the Mississippi) and GMU 23 (Norton Sount). The U.S. Navy Missile School was activated at Pomona, Calif., early in 1953 to offer a 24-week course.

Meanwhile, two heavy cruisers were being converted as the Navy's first Terrier launchers. These were the USS Boston (CAG-1), commissioned at Philadelphia Navy Base Nov. 1, 1955; and the USS Canberra (CAG-2), put in service at Philadelphia, June 15, 1945. In both, the aft 8-inch turret was removed and twin launchers installed, along with a below-decks complex of storage, servicing and automatic loading equipment, and special search and guidance radar system.

The first Terrier-equipped destroyer, the USS Gyatt, was put in service Dec. 3, 1956 at Boston Navy Yard. The fleet schedule called for having 22 cruisers and destroyers thus armed by 1961. In another application, the Marine Corps developed a technique for taking Terriers ashore in amphibious landings, for firing from mobile launchers. One Medium Antiaircraft Missile Battalion was in training in 1956 at Twentynine Palms, Calif., and a second outfit was planned.

Terrier I (XSAM-N-7) is a needle-nosed missile, 11.4 feet long and 10 inches in diameter, powered with a solid propellant rocket motor and using a Convair/Bendix guidance system. The main control surfaces are 12-inch cruciform "wings" near the midpoint of the missile body. In launching the Terrier is mounted atop a solid-propellant booster rocket section that falls away in flight. Range and performance data are secret but Rear Adm. John H. Sides, commander of Cruiser Division 6, called Terrier in 1955 "perhaps the most sophisticated weapon system in service use."

Early production was carried on at San Diego in a reactivated section of wartime Plant II, and a separate Guided Missile Division was organized in March 1951, with Gage Irving as manager. The Bureau of Ordnance broke ground Aug. 6, 1951 for the Naval Industrial Reserve Ordnance Plant at Pomona. This, the first fully integrated missile production center in America, was placed under operational direction of Convair. The Engineering Building was ready for preliminary use July 31, 1952, and transfer of personnel and equipment from San Diego was completed with opening of the Manufacturing Building in mid-1953. The operating group was renamed Pomona Division, and the manager became Charles F. Horne, a retired Navy admiral, electronics expert and former CAA administrator.

Built on 141-acre grounds, the plant includes 1,286,000 square feet of floor space. The 17-acre Manufacturing Building is entirely air-conditioned because of the care required in making missiles; final assembly is conducted in a dust-free room entered only through double doors. The Engineering Building houses extensive laboratories and a complete experimental factory. Auxiliary structures include two drop towers (one 200 feet high) and two 34-foot centrifuges, where missiles and components can be subjected to accelerations of up to 60g. During manufacture more than 30,000 inspections, checkouts and tests are made for each missile, and the completed assembly undergoes four hours of simulated flight.

In 1956 two newer surface-to-air missiles were in undisclosed stages of development at Pomona. These were Terrier II and Tartar. No data had been released on the last beyond this statement by Rear Adm. John E. Clark, director of the Guided Missiles Division: "Tartar is the blood-brother of the improved Terrier and may be simply defined as a Terrier without a booster. It is designed for use from ships as small as destroyers and for secondary battery use from larger ships......The first application of Tartar will be in the destoryer types included in the fiscal year 1957 ship-building and conversion programs." The schedule called for 17 Tartar-equipped ships by 1961.

During early stages of the Terrier development, Convair worked independently on another Navy antiaircraft missile, the Lark. This program originated in the spring of 1945, when the Bureau of Aeronautics sought a subsonic missile that might be perfected sooner than the Bumblebee project. Vultee Field submitted a preliminary design proposal in May and received a letter of intent contract June 23. (Fairchild Aircraft was also a Lark contractor and worked separately on developing the missile.)

The Convair Lark (XSAM-N-4) was approximately 16 feet long, with broad cruciform wings and smaller tail fine, and was powered with an RMI liquid (acid and analyn) rocket motor. An electronic target-seeking system was developed by Raytheon Manufacturing Co. Convair designed the control system of autopilot and moveable wings, with tail-fin trimming. A booster stage, two JATO bottles mounted in drop-off tail ring, was used in launching. More than 100 of the missiles were built and tested. The contract was terminated in 1948, when supersonic weapon types were making greater progress.

Daingerfield; Talos -- One of the many fruits of Project Bumblebee was the Ordnance Aerophysics Laboratory, established by BuOrd and APL in 1945 near Daingerfield, Texas. Convair was asked to operate it for the 14 industrial organizations and eight universities associated in the research program. The site was picked so the laboratory could use the large supplies of steam power and compressed air available at the nearby blast furnaces of the Lone Star Steel Co. Primary equipment included a supersonic wing tunnel of continuous-flow type (throat 19 by 27 inches), for testing at velocities up to Mach 2.5; and ramjet research facilities. A cylindrical high-altitude chamber, 10 feet in diameter and 125 feet long, permitted full-scale engine runups under conditions equivalent to 100,000 feet. First air was blown through the wind tunnel Nov. 26, 1945.

In the early post-war years, Convair was active in ramjet burner research. (In addition to Bumblebee, there was the XP-92 ramjet interceptor project.) The company's first burner was designed by engineers of the Nashville division in the summer of 1945 and sent to Vultee Field, where fabrication started in October. "Fairly successful test runs" with the Model A-2 were reported at Daingerfield in April 1946. A ramjet and rocket test facility was improvised at Downey (using a wartime air raid shelter for blockhouse). The equipment was moved to San Diego in 1947 and set up in a center near the company seaplane ramp.

The first Bumblebee ramjet test vehicles (RTV-N-6) were engineered and built by Convair missile group, using design concepts originated by APL. Before this vehicle (which became the Talos) was ready for pilot manufacture, Convair dropped out of the program to concentrate on Terrier production.